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THE INSTITUTE OF FRANCE AND OTHER LEARNED SCIENTIFIC SOCIETIES

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II

Great Educational Institutions in Paris, Literary and Scientific

The College of France

One of the more noted of these institutions is the College of France. This college has filled a large place in French history, and contributed not a little to French culture. It is as flourishing to-day as ever. Its history is interesting. In 1529, yielding to the desire of William Bude, provost of the merchants, a scholar as well as a merchant, and especially fond of Greek, Francis I. began the college by founding two chairs, one for Greek and one for Hebrew. Fearing heresy if such studies as these were encouraged, or even permitted, Noel Buda, syndic of the theological faculty of the University of Paris, sought to dissuade the king from his purpose. In this he signally failed. In 1530 a second chair was added for Hebrew, a second for Greek also and one for mathematics. Not long after this instructors were provided in Latin eloquence, philosophy and medicine. Poor Buda's cup was full. But he was powerless. Charles IX. established a chair of surgery Henri III. one for Arabic, while Henri IV. added chairs for botany and astronomy and completed, as he thought, the work which Francis I. had so wisely begun. At that time there were about 500 students in the college. Its work, always excellent, remained essentially the same for many years. August 1619, the year the Pilgrims were preparing to leave Holland for America, Louis XIII. laid the corner-stone of a new building, and enriched the course of study by founding fellowships of common law and Syriac. Louis XV. introduced the study of

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INSTITUT ET LE PONT DES ARTS.

The photographs used in this article were taken by J. Kuhn, 220 rue de Rivoli, Paris.

French literature. Strange to say the leaders of the Revolution did not interfere with the work of the professors of the college, but even increased their pay. They changed the name Royal to National, but otherwise approved and favored the institution. This fact alone is sufficient to indicate the place which it was filling and the affection the people had for it.

It was one of the few institutions in which every one seemed to have confidence. Napoleon added a chair for Turkish, Louis XVIII. one for Sanscrit and one for Chinese. In 1874 a chair was established for instruction in political economy. Since that time other chairs have been added, till it is now possible in this college to receive instruction from competent men in well-nigh every branch of learning.

This college is peculiar in the liberties it grants its students. There are no examinations, no diplomas, no degrees. One listens to such professors as one wishes, comes and goes as one likes. There are no registrations. The more famous the lecturer and the more popular the subject, the larger the audience. Few, save specialists, care for the lectures on Hebrew or Chinese. Those on French literature are the most popular. The largest of the nine lecture halls is then crowded. Women are always present. Those on Latin literature are fairly well attended, as are those on the middle ages, those on esthetics, those on the history of art and those on morals. It was on this last topic that Michelet delivered his famous course and was heard each succeeding year with increased interest. Yet this college with its forty professors, while affording the very best advantages for those earnest and faithful students who are able to appreciate the value of its lectures, is not well suited to the wants of young men and young women who care less for hard work than for personal pleasure. There are two semesters, the first beginning the first week in December, the second the week after Easter. Vacation begins between July 20 and July 30.

The University of Paris

A very different institution is the University of Paris, which, with the colleges grouped around it, like the Navarre and the Sorbonne, has been in the front rank of European universities since the end of the twelfth century. It became prominent, indeed, about the year 1170. It grew out of the schools connected with the churches of Nôtre Dame, St. Geneviève and St. Victor, and for some years the chancellor of Nôtre Dame claimed the right, as the quasi head of the university, to grant its licenses. A charter for a corporation with special privileges was given by Philip Augustus in 1200, and seven years later the students of the university were allowed an ecclesiastical trial. By 1229 the contests between townsmen and students had become so frequent and so bitter that many of the latter went over to

Oxford, where they remained for two years, or till the decision of Pope Gregory IX. so favored the students that they felt it safe to return to Paris. It was in this university that William of Champeaux and Abélard taught. Early in its history there were the four faculties of theology, law, medicine and the arts. In the department of the arts there were as many students as in the other three departments of the university combined. Hence in the "congregation," or board of control, the masters of the arts department had four votes, while each of the other departments had but one each. About 1250, Thomas Aquinas, Alexander Hales and Saint Bonaventura were members of the theological faculty. Their refusal to take the oath of allegiance to the university, on the ground that their obligations were to the church, was the beginning of legislation which continued for seven years and ended only with the decision of the Pope that *mendicants,* or members of orders in the church, should have the same right to teach in the university as the regular masters. The outcome of this struggle was the establishment of several colleges which were grouped around the university, but were in a measure independent of it.

The university was at the height of its fame in the fourteenth and fifteenth centuries. Students flocked to it from every part of Europe. By order of Napoleon it was made in 1808 a part of the University of France, and deprived of the rights it had enjoyed as an independent institution. Since 1898, when the law of 1896 under which fifteen universities in France were recognized and made substantially autonomous, it has regained a good deal of its former authority, although the universities are still to a certain extent under the control of the minister of public instruction. But the government, while providing for the support of the professors, no longer provides new buildings for the universities, equips laboratories, or buys books for the libraries. For these increasing needs, local gifts are expected. In the larger cities these have not failed. The increase in attendance, therefore, has been in the universities belonging to the larger cities. There were in the University of Paris in 1904 nearly 13,000 students. It is now one of the best equipped universities in the world. Its professors are among the most famous in the world. The opportunities it furnishes for study are not surpassed by any university in Germany.

The Sorbonne

The Sorbonne, one of the most noted colleges in existence, was founded by Robert de Sorbon, chaplain of Louis IX., October 21, 1250. His object was to provide for the support of poor young men while in training for service in the church. Although the students had been divided into four nations, Picardy, France, Normandy, England, in the hope and belief that they would aid each other through this closer

fellowship, poverty was still pressing. Such a college as the Sorbonne seemed to be needed. For a long time only poor students were admitted to its hospitality, and although the fare it furnished was luxurious in comparison with that which the young men had previously enjoyed, it was scant enough to justify the title the college received of "pauperrima domus." During the reign of Louis 100 scholars were lodged in it. They paid nothing. The house which the king made over to his chaplain for the college once belonged to Jean d'Orléans, and on its site with some additional space the present magnificent buildings stand.

Students in the Sorbonne have always been compelled to work. Even in the thirteenth century three severe examinations were required before one could obtain a bachelor's degree. In order to obtain the right to teach or to be known as doctor, at least ten years' study was necessary. Many theses were written, and their authors subjected to many tests of scholarship. The final examination occupied an entire day, beginning at 6 A.M. and closing at 6 P.M. There was no intermission for food, drink or exercise. Twenty wranglers, relieving each other every half hour, conducted the examination. They made it as difficult as possible and did all in their power to confuse the student.

In 1274 the Sorbonne provided courses in the humanities and philosophy as well as in theology. Its faculty has always been very conservative. It pronounced judgment against Jeanne d'Arc, condemned Luther and reform of every sort, and opposed the philosophy of Descartes. Since the revolution there has been no theological faculty. Instruction has been confined to literature and science. There are schools of law and medicine in the vicinity. The literary and scientific faculties of the university are installed in the buildings of the Sorbonne. Here also are the libraries, both of the university and of the college, numbering altogether about 300,000 volumes.

In 1821 the professors of the university complained that their laboratories were too small and their examination rooms inadequate and dark. It was in this year that the schools of the Sorbonne, which had been closed by the revolution, were reopened. Its property had been taken by the state in 1801. Renting it for a time, the state finally turned it into a lodging house for artists, sculptors, painters, architects and men of letters.

The complaints of the university brought up the question as to the ownership of the property. Was its title in the state or in the university? Legislation was protracted, but a decision rendered in 1852 gave the property to the university. Meanwhile the university faculties continued to ask for more room. There must be, they said, new laboratories for the proper study of chemistry, zoology and physics.

LA SORBONNE, PARIS.

A government commission, after a careful consideration of the petition of the professors, reported in favor of granting their request. Nothing came from the report. In 1846 there was another commission and another favorable report. Still there was delay. In 1855 a decree for immediate reconstruction of the buildings was passed and a cornerstone of what was supposed would be a new and adequate building was laid with great rejoicings. But nothing more was done till 1871 when there was another commission and another favorable report. Money for rebuilding was not secured till 1885. New and enlarged plans meanwhile had been made, and the work of construction was put into the hands of a young man who had been in the practise of his profession less than five years. But he had been carefully trained both in Paris and in Rome. The cornerstone of the new Sorbonne was laid August 3, 1885, in the presence of Jules Grévy, president of the republic, the minister of public instruction and the faculties of the university. Four years later the edifice was ready for dedication. It had cost 22,000,000 francs. It is a model of its kind, severely simple yet beautiful in its adornments and its harmony. At the dedication on August 5, 1889, there were present President Carnot of the Republic, with the members of his cabinet, the officials of the university, representatives of foreign countries and foreign universities and members of the different academies connected with the institute. For its purpose the building is said to be one of the finest in existence.

INTERIOR OF THE SORBONNE.

In it are installed the faculties of mathematics and natural history, as well as those of literature. Here are their class-rooms and about forty of their laboratories. Other laboratories are in the museum, or in the Jardin des Plantes, the medical school.

The Sorbonne is now a practical school for advanced students. It has been defined as a complex of historical and philological seminaries of scientific mathematical institutes which owe their existence to the initiative of Minister Duruy in 1868, and are designed to supplement the theoretical instruction of the university with experiments and a visible demonstration of the truth of principles laid down in text-books or set forth in the lectures of professors.

The Sorbonne furnishes only a few lectures which are free and open to the public. These are given by men of note not connected with the university, and are on topics of commanding interest either in literature or in science. It is needless to add that these lectures attract many listeners. The training in the Sorbonne is better than ever and is worthy its history and its fame.

The Museum of Natural History

Another of the institutions which is an honor to Paris and to the French people is the Museum of Natural History, or the Jardin des Plantes. It attracts visitors from every part of the world and arranges many profitable courses of study. It was known at first as the Jardin

des Plantes, but after the revolution as the Museum of Natural History.

Begun in 1633 as a royal garden, its design was to furnish better opportunities for the study of pharmacy and to preserve rare specimens of flowers and herbs. The garden was in reality founded by the two physicians, Herouard and Guy de la Brosse, in the time of Louis XIII. There was a garden of apothecaries in Paris in the fifteenth century. But one far more extensive than any yet known was desired, one in which botany could be studied with advantage to medical science. The king favored the proposal of Herouard and de la Brosse as early as 1626, but as the faculty of the university opposed it, nothing was done till 1633. The garden was placed under the charge of la Brosse as superintendent, with Herouard as assistant. The latter soon died and his place was taken by Charles Barnard. Salaries were small, yet sufficient to support life. Three demonstrators and an operator in botany were appointed and a small sum of money was set aside for purchases and the payment of extra help. The garden was to contain a sample of all simple and compound drugs. It consisted of twenty-four acres and was situated in the faubourg of St. Victor.

To this garden la Brosse gave his life. He laid out the grounds, planted herbs and trees, formed collections and organized courses of study in botany, chemistry, natural history and astronomy. By 1640 there were 2,560 specimens of plants for examination, all of them valuable. Under Vallot, the successor of la Brosse, the garden suffered, but under the direction of Fagan, a nephew of la Brosse and the chief physician of Louis XIV., it improved. Things went from bad to worse under Chiroc, who cared for nothing but anatomy, but under Dufoy, a real lover of nature, there was a change for the better. He made Buffon his successor, who, from 1739 to 1788 was at the head of affairs and whose ideas of what the garden should be were largely realized. Cuvier followed him. Cuvier came to the garden a poor boy, well educated in the classics, mathematics and literature, but supremely fond of natural history. He was soon made a professor. He studied comparative anatomy and through his contributions to this branch of knowledge gained great honor. He was a professor in the College of France, a member of the French Academy, of the Academy of Inscriptions and Belles Lettres, and of nearly all the learned societies in the world. But he permitted neither honors nor requests from any source whatever, to interrupt his favorite studies. His modest home was in the garden itself, and during his lifetime was the meeting place of most of the more famous scientists of Europe. The house, covered with vines and adorned with a bust, is preserved, and marked as the house of Cuvier.

Through the influence of Bernardine de St. Pierre the convention

added a menagerie to the garden, a building for the library and other uses, and completed the amphitheater. In the hall of design provision was made for the study of animals and flowers. Although open to both sexes, the lectures, in botany especially, were more popular with young women than with young men. The menagerie, formed by Louis XIV. and installed in the park at Versailles, amounted to little in the time of Louis XV., and in 1795, when given over to St. Pierre, it was an insignificant affair. Under skilful and intelligent management it grew rapidly. At present it contains more than 1,200 different animals, whose food alone is a very large item of expense. Milne-Edwards was for many years at the head of this menagerie and by his management added very much to its usefulness and its fame. He was succeeded by his equally famous son. The museum is a place for study as well as for the casual examination of attractive specimens. There are two semesters each year, and the courses are so arranged as to parallel those of the College of France and the Sorbonne. The same professors do not teach in successive semesters. Each one of them devotes a portion of the year to research. A special advantage in the instruction given here is that pupils are shown the objects described, and are taught to observe and describe for themselves.

There is a course in which the characteristics of annelids, molluscs and zoophytes are described, another in which attention is directed to the organization, habits, changes and classification of insects, spiders, crustacea, another in which the organization of animals, the physiology and classification of fishes are studied and in which conferences are given on reptiles. In fact, provision is made for instruction in almost every branch of natural history. In the galleries of the museum the rarest specimens are found.

Perhaps the schools of botany are the most important connected with the museum. These were organized by Brogniart, though it is true that the botanical school is older even than the Jardin des Plantes. Women in good King Henry's time had a love for flowers and studied them as well as they could. Jean Robin, a gardener of repute, dealt in choice flowers. He brought some precious seeds and roots from Holland which he refused to sell at any price. Guy Patin failed to obtain them even by stratagem. But la Brosse succeeded where others could not, for he employed Robin's son as a demonstrator in the garden, and thus persuaded the father to part with some of his precious possessions. There are two courses in botany, both under the care of able and eminent men. The garden is so arranged that it is easy even for a visitor to learn the names and species of the plants and flowers which it contains. Instruction is given in paleontology with special reference to the fossils of later geological epochs. There is a course in vegetable physiology as applied to agriculture, one in general phys-

iology, one in physics, one in chemistry and one which was introduced by Cuvier in 1795, in comparative pathology, anatomy and anthropology.

The new zoological galleries, begun in 1882 and opened to the public for use in 1889, were during his life under the care of de Quatrefages.

The museums of geology and mineralogy are very large and complete. In the building in which they are found are the library, the herbarium and the orangery. The museum celebrated its hundredth birthday in 1896. Its treasures are nearly all accessible to the public, although there seems to be a love for destruction on the part of the public against which constant watchfulness is necessary. Eminent as the professors in the museum are in the scientific world, they devote themselves so completely to their studies that in Paris many of their names are unknown.

The Observatory

It was to meet the wants of members of the Academy of Sciences, as well as to take the lead in every form of scientific work, that Colbert with the approval of Louis XIV. laid, in 1666, the foundation of what has proved to be one of the best observatories in Europe. A good deal of astronomical work had been done in the previous century: at Cassell, and at Unranienberg, where Tycho Brahe had been stationed and where his observatory late in the century was destroyed by the fury of the people and he himself compelled to flee to Germany for protection. During this century nearly all the observatories were private property and were poorly equipped. In the next century greater interest was taken in astronomy and many of the superstitions connected with its study had passed away.

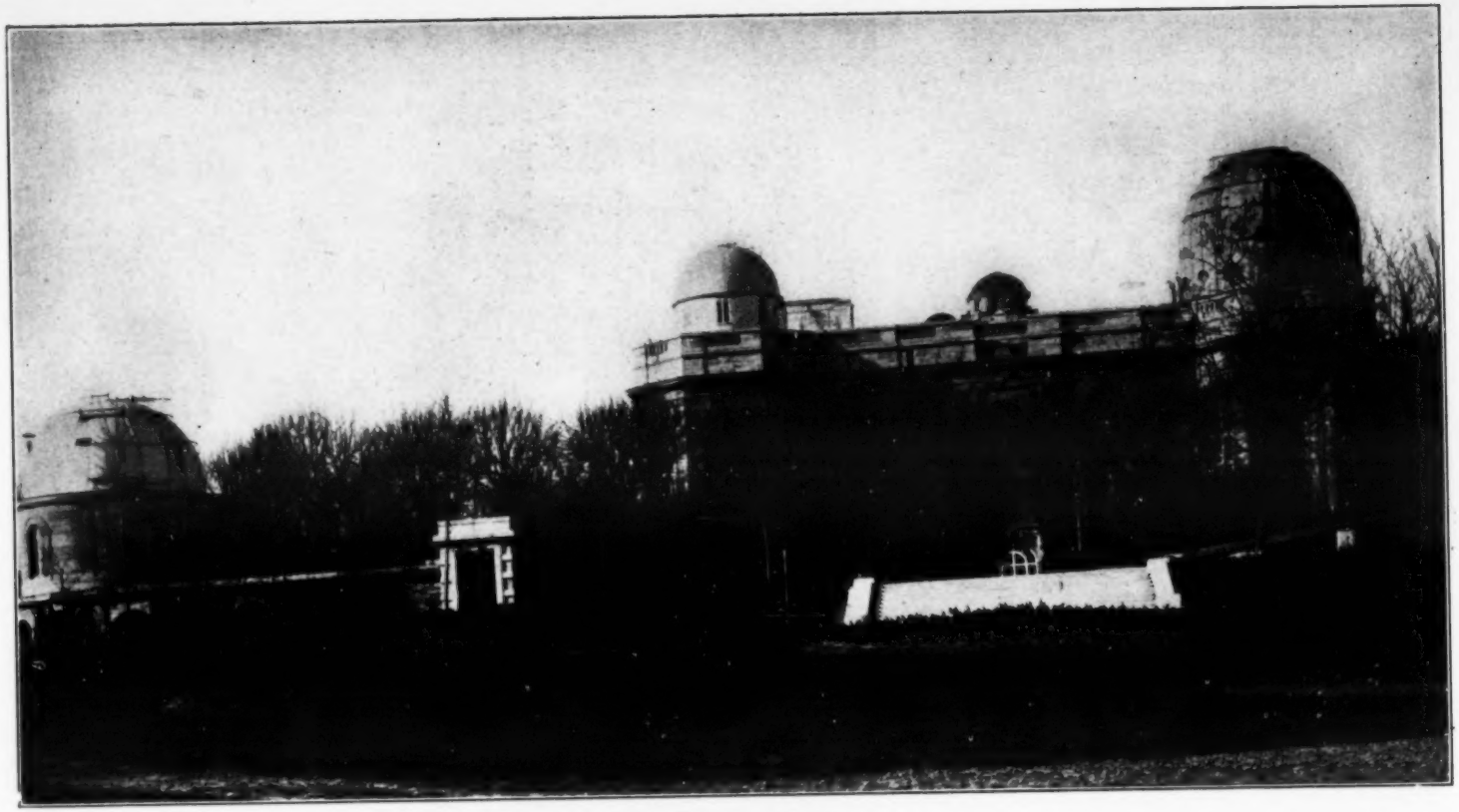
It was quite natural that Colbert, who was determined that if possible Paris should be the scientific as well as the literary center of Europe, should persuade the king to make generous provision for an observatory and to invite the most eminent astronomers living to make Paris their home. Jeán Dominique Cassini was brought from Italy and with him were associated Frenchmen hardly less eminent than he, Philippe de la Hire and the Abbé Picard.

The observatory was on St. Jacques street over the catacombs, some of which were utilized as laboratories and as lunettes, an object glass being placed at one end and an eye glass at the other. An interesting account has come down to us of a visit of the king to the observatory on May 21, 1682. He was received with becoming honor, and the working of the instruments, in which he seemed deeply interested, was carefully explained to him by Cassini and his associates. The site which members of the Academy of Sciences had selected, June 21, 1667, was an attractive one. It was in the midst of gardens and yet commanded

the entire horizon. An attempt was made at that time to fix the meridian line, but this was done more accurately by James Cassini, son of J. D. Cassini, in 1733. Imperfect as were their instruments, large sums of money were expended on them, and excellent work was done. The principal marvels of the heavens were discovered, the sun's rotation on itself, the revolution of Mars, Venus and Jupiter, the nebulæ, variable stars, four of Saturn's satellites and the division of his ring. Cassini's atlas of the heavens of sixty-two pages or plates was graciously accepted by the king as a gift from the astronomer. Huyghens of Holland succeeded Cassini as director of the observatory and he was followed by Roemer, the Dane, who discovered the velocity of light. Although after the death of Colbert in 1683 the resources of the observatory were diminished, the astronomers continued their work and by their discoveries brought fame to the nation. After 1689 and for many years, it is said, their salaries were only one third of what they had been in the time of Colbert.

The work of the astronomers of the seventeenth and eighteenth centuries has sometimes been treated as of small importance. But it was as good as the means for the study of the heavens permitted. The French astronomers, according to the testimony of Airy of England, did the best work in the world. Their efforts to measure accurately a degree of the meridian attracted universal notice. In this work the Abbé Picard was prominent. J. D. Cassini, his son James, Philippe de la Hire and a few others visited India and America to secure favorable observations. In 1755 Godin, Bougner and la Condaminer went to Peru, Maupertuis and Clairvant to Laponie, le Maurier and the Abbé de la Caillet to the Cape of Good Hope. The transit of Venus in 1761 was observed with great care. The abbé Chappe d'Auteroche went to Tobolsk, Francis Cassini de Maury to Venice, and Pingré to the island of Rodriguez. Observations were also made at San José, California. In 1769 other observations of the transit were made, but war with the English prevented some that might have been very valuable.

In 1770 the condition of the observatory was discouraging. Reports were to the effect that it was dangerous to occupy the buildings. The ministers of Louis XVI. aided J. D. Cassini de Thury in his work. But perfect instruments and promised repairs of the buildings were insufficient to persuade Cassini to remain in Paris after the Revolution and the decree of 1791. In June of this year the convention turned over all the observatories of France to the Bureau of Longitude. Under the influence and direction of such men as Laplace, Delambre, Legendre, Lagrange, Michain, Arago, Bouvard and his son, Mathieu and Mauduis the observatory regained its former reputation and even added to it. Still, as late as 1832, the astronomers found it neither altogether safe nor comfortable to live in the quarters provided for them.



L'Observatoire de Paris.

Since that time the government has been generous. The republic has not been behind the kings in providing the observatory with resources. Its directors have been men of the highest standing in their department, and the work which has been done has been of the utmost importance, unsurpassed by that of any observatory in the world. Equipments are now as good as can anywhere be found. The new building is entirely of stone. The new telescope has an aperture of 1 m. 7.' Its weight is 10,000 kilograms. For twenty years improvements in buildings and apparatus have constantly been made. It is not probable that the observatory will be moved from Paris, although the site is not the best that could be obtained for all kinds of work. But as there are other observatories in France so that observations which can not be taken in Paris can be taken elsewhere, removal is

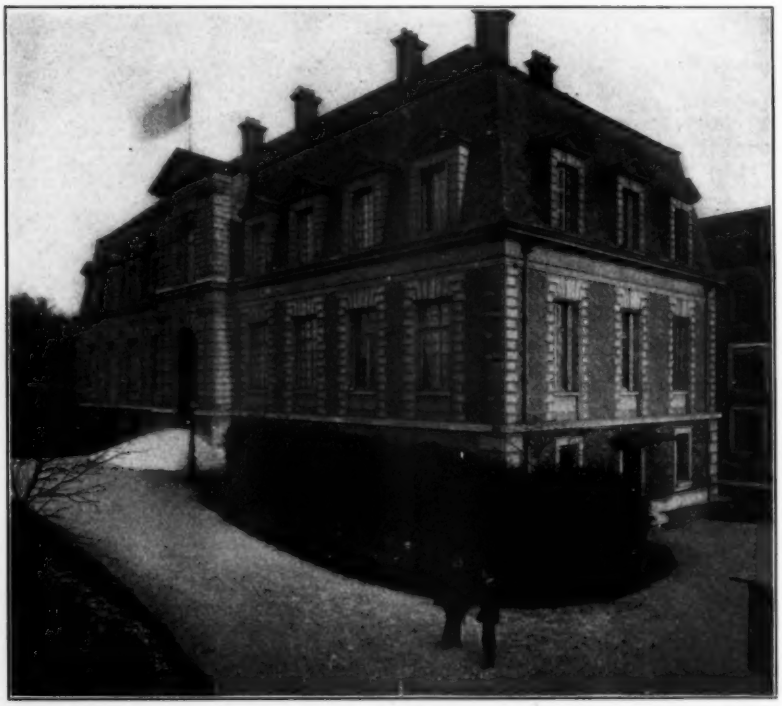
L'Observatoire de Montsouris, Paris

not essential, perhaps not desirable. The establishment for the study of astrophysics is at Meudon and is under the direction of Jansen. Its work is of the highest order.

The Pasteur Institute

Though not altogether a school for scientific research, the Pasteur Institute is one of the most interesting and instructive establishments in Paris. As it is the outgrowth of the energy, skill and devotion of one man, it is fitting that considerable space should be given to his history. Louis Pasteur, the son of a tanner, was born December 27, 1822, at Dole, in the Jura. He began his studies in the college of

Arbois. His father, an old soldier, was anxious that his son should be a professor in a communal college. The young man took a course in philosophy at Besançon, where at eighteen he began to teach. Three years later he had prepared himself for the normal school, but delayed entrance till 1844, in order that he might enter with higher rank. In the normal school he specialized in chemistry, under Balard and De Lafosse of that school, and under Dumas of the Sorbonne. The Sorbonne made him doctor of science in 1847. Leaving the normal school in 1848, he accepted a professorship of physics in the Lycée of Dijon, where he gained fame by his researches into the structure of crystals. In 1854 he was made professor of chemistry at Strasbourg, dean of the



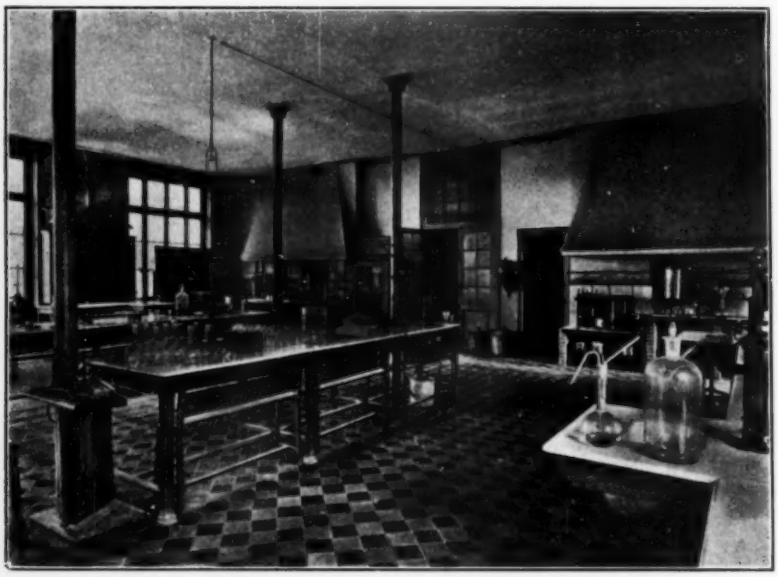
L'INSTITUT PASTEUR.

faculty of science of Lille in 1854, director of studies in the normal school in 1857, professor of geology, physics and chemistry in the school of fine arts in 1865, professor of chemistry in the Sorbonne in 1867. These dates indicate the rapidity of his promotion and the nature of his activity. For several years prior to his appointment to a professorship in the Sorbonne, he had studied infusoria and had reached conclusions directly opposed to those held by Pouchet, the director of the Museum of Natural History, at Rouen. Pasteur was confident that infusoria were from germs, or microbes, and that they fixed themselves in sub-

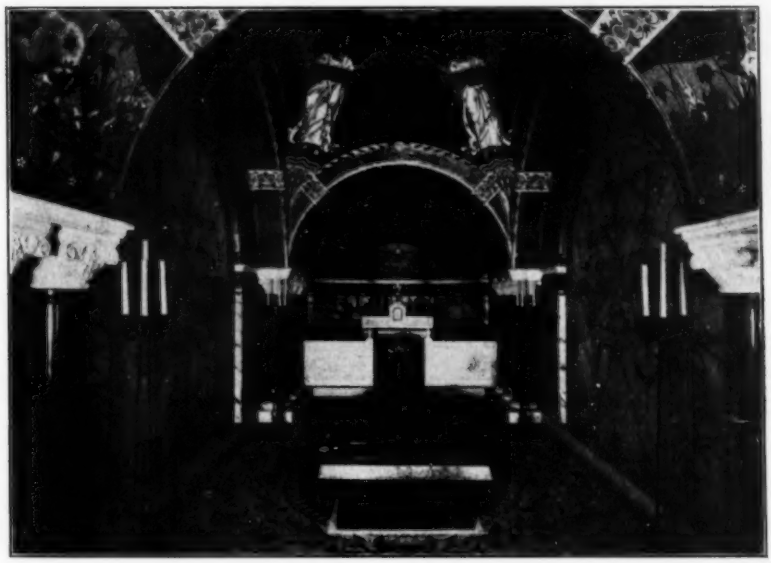
stances where they could obtain nourishment. As early as 1854 he had discovered the *ferment lactique,* which causes milk to sour. He studied also what was called the ferment of butter, wine and vinegar, and soon found out a way by which wine could be turned into vinegar with great rapidity. The silk industry in the south of France having been threatened with destruction, a commission was appointed, with Dumas of the Sorbonne at its head, to study conditions, and if possible report a remedy. Dumas sent Pasteur to Arlois, where he remained most of the time from 1865 to 1868. The difficulty was found in the *papillons* and was easily remedied. For some reason not given, he returned in 1871 to Bonn the diploma for a professorship which had been granted him in 1868. From this time he began to turn his knowledge to practical use. Honors came from all quarters. In 1869 he was elected a foreign member of the Royal Society, London. In 1856 he had received the Rumford medal, in 1861 the Jenner prize and in 1874 the Copley medal. In 1872 the London Society of Arts offered him the Albert medal and in 1883 the University of Oxford made him doctor of science. Money also came to him with the expectation that it would be used in the increase of practical knowledge. In recognition of what he had done in saving the silk industry, through the minister of agriculture, Austria-Hungary gave him in 1868 10,000 florins, about $5,000. The Academy of Sciences in Paris received him into membership in 1862, and in 1875 the Academy of Medicine, although he was not a physician, made him a free associate member. The same year a prize of 12,000 francs was given him for his services in promoting industry, and in 1874 the French government voted him a pension of 12,000 francs. In 1881 he was received into the French Academy as one of the Immortals. As early as 1868 he was a commander of the Legion of Honor and was pushed forward as rapidly as possible for the reception of the Grand Cross. Such astonishing recognition could not come except for what the public, as well as scientific men, deemed good reasons. These reasons were his services for humanity. For Pasteur was one of the men whose nature compels them to make practical use of whatever knowledge they gain, whether from books or from experiment. Though men of science had long known something of his ability, his lecture in 1868 on the madness which follows the bite of dogs afflicted with rabies first brought him to the notice of the public. Yet he did not begin the systematic study of rabies till about 1880. He had already found a vaccine for the cure of chicken cholera, and the suggestion had come to him that perhaps the bite of mad dogs might be cured in the same way. Up to 1880 his laboratory had been in the normal school. But in view of what seemed natural to expect from him the municipal council gave him the use of the old garden belonging to the Collège

Rollin, where he kept and experimented upon sick sheep, horses, chickens affected with cholera, mad dogs and guinea-pigs. At the end of five years of study and experiment he was satisfied that his remedies would prove effective for animals, but was skeptical as to their efficacy with men. While in doubt a boy of nine by the name of Meister, from Alsace, was brought to him for treatment. He had been bitten eleven times, and his case was thought hopeless. Drs. Vulpian and Graucher advised Pasteur to try his remedies on him. He might live. He would die unless something was done for him. At about the same time the boy Jupille, who had shown such bravery that the academy had voted him one of its prizes for "Vertu," came to him. Both were cured. Great popular enthusiasm followed. People who had been bitten by mad dogs and who had thought there could be no help for them came every day to the rue d'Ulm where Pasteur was at work. In 1886, of nineteen Russian peasants, several of whom had been bitten in the head, fifteen were cured. Quarters soon became too small. Confident in his remedies, and in himself, Pasteur now appealed to the public for money for a new site, larger buildings and opportunity for more extensive experiments. More than 3,000,000 francs were contributed. The new building, which was very plain, was put up at Vaugrinau, and opened November 11, 1888, with great éclat. The president of the republic was there and with him some of the most distinguished men of the day.

More than one hundred persons every day are inoculated with the healing vaccine. The course of treatment occupies about eighteen



Laboratory of Dr. Roux in the Pasteur Institute.



TOMB OF PASTEUR IN THE PASTEUR INSTITUTE.

days. Those bitten about the head are the most difficult to cure. Yet with all the drawbacks not more than five cases out of every fifteen hundred prove fatal. It is natural that the French people should look upon Pasteur as one of their greatest men and as worthy of the highest honor. It is for this reason that they have responded so freely with their gifts when additional means have been required for the work of the institute. Since Pasteur's death his work has gone forward successfully. One of his pupils, Dr. Roux, has discovered a vaccine which is said to be an almost sure cure for croup and diphtheria. Other physicians are seeking through experiment and special study new and better methods of treating what has hitherto been regarded as fatal disease. It is needless to add that Pasteur's remedy for rabies is now made use of in every civilized country.

The great buildings of the institute are used chiefly for its patients, yet in connection with them places are found for those who wish to study its methods and watch its experiments. A special course of study covering several months is open to all who wish to take it, though those who do take it are expected to pay a small sum for tuition and to meet their personal expenses. Perhaps no establishment in the world has contributed more to the sum total of human happiness than the Pasteur Institute, which is even now only in the beginning of its career.

The Normal School

This article must close with a few words concerning the normal school which is one of the most prominent educational institutions of

Paris, and indeed of the country. The normal school, as its name implies, is for the training of teachers, perhaps it would be better to say for professors in the lyceums, the colleges and the universities not only of Paris, but of France.

Normal schools are of two classes, elementary and higher. The elementary were first established, though not without considerable opposition. At present no one can teach without a certificate from one of them. Instruction is free for those who are accepted as candidates for teachers; oftentimes board and lodging are furnished. From the elementary normal schools, which are the most numerous and of which at least one is found in every department of France, come the men and the women who train the children who are in the primary schools of the nation. The state meets the expense of running these elementary training schools, but the departments are required to provide buildings and the necessary equipments for them.

The higher normal school was organized in 1795. By a decree of November 10, 1903, which went into effect a year later, it was made a part of the University of Paris. The instruction furnished by the university is open to members of the Paris school, to whom many other special advantages are granted. Candidates for entrance into this school are limited in number and are received only after a severe examination. None are received who are under eighteen or over twenty-four years of age. The course extends through three years, and is scientific or literary, as the student at his entrance desires. In consideration of the provision made for his support while in the school, he promises to teach at least ten years after graduation, or to refund the cost of his training. This training is practical as well as theoretical. Each pupil is called upon during his course to exercise his skill as a teacher in giving lessons to his fellow students, and is required to spend some weeks in one of the secondary schools of Paris. Probably there are no schools in the world where more care is taken in the training of teachers than in France and no one of the higher normal schools has done, or is doing, better work than that in Paris. In it some of the ablest men of France have been trained.

THE GRAYLING AT CARIBOU CROSSING

By President DAVID STARR JORDAN
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SAINT AMBROSE, of blessed memory, a fisherman of old, likewise a fisher of men, "magnanimous, plaintive and intense," once declared in his town of Trêves in Gaul, Trêvirorum of the Black Gate, fifteen hundred years ago, that the grayling was "the flower of fishes." This it certainly is, the most choice, the most unhackneyed, of all the prizes of the angler.

The Latin name of the grayling, *Thymallus,* comes from the fact that, when fresh, the fish has the odor of wild thyme, a fragrant mint, common on the brooksides of Northern England. Shakespeare knew on the Avon in Stratford "a bank whereon the wild thyme grows," and I too have found in fragrant Warwickshire many a slope which well answers to Shakespeare's description. But though the grayling is a sweet fish, pleasant to smell as well as to see when it comes forth fresh from the ripple, yet I have never been able to detect the odor the ancients knew so well.

The grayling is cousin to the trout. Its mouth is smaller, its teeth are not so sharp and it has neither the strength nor the speed nor the voracity of the least of the trout. Its scales are larger than in any trout, and there are blue spots as well as black spots on them on a gray background. There is never any red, and from the prevailing gray comes the fine old English name of grayling, as well as the German name of æsch.

The shape of body and fins is like the trout. The little adipose fin is there just the same as in the trout. But the dorsal fin is different. It is much higher than in any trout, and it has more rays. It rises up like a sail and it is marked by sky-blue spots which give the fish a distinguished appearance when it is at home in its native waters.

The grayling lives in swift, clear streams—not often in lakes. It calls for colder water than the trout, and so its range is farther to the north. Indeed, it is comparatively a rare fish outside the Arctic circle.

The different species of grayling are all very much alike in looks as well as in habits. The common grayling of Europe is *Thymallus thymallus.* It ranges through northern England, Scotland, Scandinavia and Russia. There is, likewise, a species of grayling spread all over Siberia, but we know very little about this fish, and are not sure what species it is.

Through the Yukon region of the great northwest, there is a grayling, very abundant in the right waters and bearing the name of the standard-bearer, *Thymallus signifer*. In the old days, after the great glacial ice, this fish extended to the eastward over a much larger area, but the ice has melted away, and there are left three isolated colonies to the southeast of the main band. One of these colonies is called *Thymallus ontariensis* or *tricolor* and lives in certain streams, notably the Jordan and the Au Sable, in the sandy woods of the southern peninsula of Lake Michigan. In both these streams the grayling is growing scarce through the combined evil influence of the lumberman and the trout-hog. In the northern peninsula, there is another isolated little colony. Let us call its stream the Nameless River, and if we leave it so the thyme-scented fish may increase to fill other rivers which are not nameless.

The remaining colony, a little changed from the other two through long isolation, is in Montana, at the head of the Missouri River. The Montana grayling is called *Thymallus montanus*. It is most plentiful in the Gallatin River, and if you look through the mountains till you find Horsethief Creek, you will be sure of at least one day's good sport. It will take all day to find the creek, no matter from where you start.

And this brings me to describe my best day's sport with the grayling. It so happened that in June, 1897, the present writer was in the city of Juneau, the metropolis of Alaska. That day, the Canadian surveyor, Ogilvie, since noted in Klondyke history, had reached Juneau from up the coast and across the mountains with a wonderful story of the happenings in the northwest territory of Canada, on the banks of the middle Yukon. It seems that the Indian Skookum Jim of Caribou Crossing, with his friend Tagish Charley, a squaw man Siwash George, and his wife, who was Skookum Jim's sister, were wandering across the country, supposed vaguely to be in the interest of one Anderson—looking for gold.

Away down the river beyond Lake Labarge, one of the men took sick. He had eaten too much blubber of some sort, and the wife of Siwash George went down to a brook to get him a basin of water. In the bottom of the basin was a streak of fine gold. They went down to the stream and bailed out more. Then Skookum Jim, as his name would indicate, started out swiftly at the top of his speed, "touching only the high places," to record with the Dominion authorities the claim of himself and his associates. Skookum in Chinook means swift, hence Skookum Chuck—a waterfall. Bonanza Creek, Klondyke, Dawson then at once became names and then realities, and all the world knows their story. Skookum Jim, a millionaire, built himself a large house of pine lumber at Caribou Crossing. He went to Seattle to buy a Brussels carpet for its floor. When the carpet came it was too broad by nearly a yard for Skookum Jim's best room. So he had

the house cut apart and spread until the room was large enough for the carpet. How Tagish Charley became one of the generous rich, beloved of all men, and how Siwash George deserted the woman who made his fortune for a San Francisco actress, all this, with the spectacular career of Swiftwater Bill, are known to every one in touch with the gossip of the smart set of Caribou Crossing, Seattle, and San Francisco.

When Ogilvie told all this in Juneau, the whole town responded. Juneau itself lay on the very frontier of adventure, and here was something newer and greater and only two thousand miles or so beyond.

So the gamblers and gold seekers, the clerks and lawyers resigned their positions, threw up their jobs, in some way or another made their way to the head of navigation, Dyea or Skagway, and then struck the White Pass Trail. The Bright Eyes Opera Company broke its engagement at Juneau and men and women started over the mountains to Bonanza Creek. And after them came a most wonderful migration —one of those movements which, if anything could, lend "to the sober twilight of the present, the color of romance."

All the way southward, the word went from Juneau. Cigarette young men, who had never done a man's day's work in their lives, crowded the smoking rooms in the Pullman cars, and pampered dogs —St. Bernard, Great Dane, Mastiff, brought up in luxury, and bought or stolen to do the work of a husky or Siberian wolf dog—rode in the baggage cars. Along with the rest came young women and old women, dainty Mercedes, silly, pretty and whimsical, demanding the impossible, elderly graduates of cheap boarding houses with iron hand and iron jaw, capable of making some sort of a way anywhere. All were loaded down with clothing and provisions needed for an Arctic winter. Most knew nothing of hardships, nothing of dogs, nothing of trails over glacial mountains and through endless chains of rock-bound lakes, each hidden in its cleft of rocks. They knew nothing of boats or rafts, or the breaking up of the ice, nothing of gold or men or Alaska. And the dogs were just as ignorant, and had not even seen a map of Alaska, and did not know beforehand that they were going there.

From Skagway—a wild bedlam of incongruous elements, with its hero mayor, chief of the Vigilantes—the trail goes up the boisterous river, through the fir woods, past the mouth of glaciers, into a great amphitheater like that at the foot of the Splügen Pass, then in long zigzags and windings past reckless splashing waterfalls and unbridged chasms to the foot of the moss-covered White Pass. Then up the pass to its gusty Summit Lake and the long ravine-like chain of lakes at the head of the Yukon which may keep one guessing for miles as to the way past or around them.

In a sheltered depression on the summit is a place which should be historic. Here every band of pilgrims has camped for the night. Here it has cast away its luggage, discarded its horses, abandoned its dogs. Into the springy heather-grown basin, sheltered from the wind, we may find trodden into the muck harnesses, sleds, bottles, cups, plates, hats, trousers, neckties, bones of dogs, bones of horses, ravens, newspapers, playing cards, cigarette papers, shirts, collars—every evidence of a failing civilization. The dead ravens tell the story of their premature attacks on dogs and horses, for the men have pistols, and they are the last to go. Near this place, some later humorist has built a house of empty beer bottles, set together with mortar—a house big enough to shelter you and me from the storm. Bones of men are strewn along the way—you can trace the trail by the soiled and dislocated heather—but all these, so far as I know, have had a decent burial. Some of them, to be sure, were buried under avalanches, but that was on the south side of the pass, near the foot of the great unnamed waterfall, over which unheeded flows the Nameless River. We have passed the waterfall and the river, and are now well down on the Yukon side. The little ice-cold Summit Lake, where more than one loaded team and its teamsters went through the breaking ice, is said to be well stocked with trout. Men described these to us as Dolly Varden trout (*Salvelinus malma*). As the lake flows into the Yukon, and as the Dolly Varden is not found in the Yukon, which has only the Great Lake trout or Mackinaw trout (*Cristivomer namaycush*), we developed a geological theory that the Yukon had stolen this lake from the Skagway. The theory looked not unreasonable. Rivers do such things. At the head of the lake was a little dam of glacial drift. Cut through this dam, and the head of the Yukon would flow down into the Skagway. Perhaps it did so in the days before this dam was made. But facts are facts. Let us see what kind of trout lives in the lake, and we will tell you its glacial history. My companion, Professor Harold Heath, borrowed a fly and cast into the lake. We had one rise, and landed the fish. It was the Great Lake trout and not the Dolly Varden. So we laid our theory on the shelf and allowed the Summit Lake to remain in the past as it is in the present, a head-spring of the Yukon. I said that rivers do such things. At the head of the Roanoke River, near Allegheny Springs, in Virginia, is a valley which the Roanoke has stolen—fishes and all—from the Holston River, on the other side of the ridge. To steal a valley is to undermine it gradually from the other side, until the water in the first valley turns and flows the other way. But the Yukon has stolen nothing from the Skagway, and on second thought it deserves no credit for its reticence.

It looks cold to the north of the White Pass, even in midsummer. Down the long rock-ridges between the lakes goes the trail —on and on through reindeer moss and heather, all the way above

timber line, down to Lake Linderman, long and narrow, like a gigantic rock-bound ditch of the giants. Down the long shore of Lake Bennett, through scrub and swamp, birch and brambles. No wonder so many took to the ice, rotten though it be in early summer. No wonder so many tried to make rafts of logs, when the wind blew in the right direction. On and on down the straight shore of gusty Lake Bennett, two days' march it may be. Then you come to Caribou Crossing. The caribou is the native reindeer, and here in the interval between Lake Bennett and Lake Tagish, with Lake Marsh beyond, is the only place for 500 miles where a herd of caribou can cross the Yukon River. Let us cross it quickly, too, for the water is very cold, and deeper than a man or a caribou likes to wade. Here at Caribou Crossing lived and worked for a generation Father Bumpus, of blessed memory, bishop of the Yukon. And here still lives his charming wife, born to the soft skies of England and the gentle ways of English society, but here a power for good in the wilderness to which she gave her life. It seems to me that if the Church of England were all-wise, it would some time send his grace, the archbishop of Canterbury, to exchange places for a year with the bishop of Yukon. The bishop of the boundless hills would learn something in Canterbury, no doubt, but consider what the archbishop of Canterbury would learn were the seat of his diocese for a year at Caribou Crossing.

From the Caribou Crossing the river curves through the fir woods to the right—for we are below timber line again. Then it sways forward, running through a couple of lakes into a swift gorge—the famed and fated White Horse Rapids—below which it widens out into the immense Lake Labarge, which runs to the northward as far as the eye can see, and a good deal farther. Some men—about one in ten, perhaps—preferred to take their chances in running the White Horse Rapids, rather than to carry their belongings over the Caribou Hills. Some of these—one in two, perhaps—got through safely. The rest went to swell the romance, the terror, the tragedy of the gold of the Klondyke and the White Pass of the Yukon.

But the Caribou Crossing is full of fish, and some of these—lake trout, cisco, pike, ling, sculpin—take the hook when it is properly baited. You can stand on the little wharf in front of the Bishop's House, or on the bank in Skookum Jim's dooryard and cast for grayling and the grayling will respond. Better than this, you can cross the river and go a couple of miles across the field and around a bayou where the wood begins. In the little forest you will find a roaring brook and at the foot of a cascade you will find the grayling as eager as you are, and, if you are contented with a reasonable basket, you will fish awhile, then lie down on the heather and take for yourself something better than many fishes—that which Wordsworth called the "harvest of the quiet eye."

WHAT IS MATTER?[1]

By Professor S. E. MEZES
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THIS question is at once the earliest and latest to excite scientific curiosity. It was asked at the dawn of science by Thales and Anaxemander, by Heracleitus, the gloomy, and Democritus, the smiling, philosopher. And to-day, with all the resources of modern science at their command, Thomson, Ramsay, Lodge and Rutherford are still asking, What is matter? What is the stuff of which the world is made? The great difference is that at last the solution seems about ready for acceptance, a solution so simple that we must marvel at the denseness of the human wit that so long failed, and in large measure still fails, to recognize it, though it was proclaimed, in dark words to be sure, by Heracleitus in the early fifth century B. C.

There is, of course, no question as to the reality of matter. That has never been seriously doubted. With the problem properly stated, even Bishop Berkeley would not have done so, though unquestionably he thought he did, and many since his day have been misled by his self-deception. Berkeley merely disagreed, rightly, with the common view of what matter is. Matter, he taught in effect, is very different from what the man in the street thinks it to be. And to Berkeley's real doctrine the doughty Dr. Johnson had no answer. By kicking the stone, he reassured himself that matter is real, which needed no proof, but failed to cast the faintest glow of light on what matter is, which is the real question.

Before reflection, all men think they know matter perfectly. Why, they say, matter is the commonest thing in the world; it is everywhere, which is, of course, true. And they are likely to add at that stage, Everything is matter, which is false as matter is ordinarily conceived. But, if you are still unsatisfied and press to be told definitely what matter is, the man in the street is likely to resort to the "when" definition, so dear to childhood, as did Dr. Johnson, that colossal wayfarer. Matter is "when" you kick a stone, or when you see a tree, or eat its fruit, or hear the thunder roll. Now, it goes without saying that matter is in fact there when you do each of these things. But so is much else besides, including yourself, the sorenes of your toe, if you kick hard enough, the color you see, the savor you taste, and the sound you hear. But matter, of course, is not pain, color, taste or sound, any more than it is yourself or any other self. All these experiences of

[1] Presidential address before the Texas Academy of Science, revised and adapted.

ours are there with matter, but matter they simply are not, either singly or all together. Color is with its beauty, in the eye, or rather the mind, of the beholder, and there too is sound with its melody, and all other *experiences*. They are the effects wrought upon us, through the intermediation of our sense organs, *by* matter. Given an adequate outer cause, an eye in its organism to be affected, and a mind to perceive, and color is the result. Given cause, ear and mind, and we have sound; or cause, touch organ and mind, and we have the feeling of hardness. But matter, without sense organs or mind, can not have such experiences. And the substance of matter they are not. We know so much about the total situation when matter is present that we easily delude ourselves into thinking that we know the matter too. But, as Dr. Higgins once said, in dealing with experiences we are merely playing with the pebbles on the beach; the sea of reality, matter itself, is still beyond our ken. What matter is not, its effects on our senses, is plain. But what it is, all such talk leaves as dark as before it was uttered.

And, until recently, science has been as dumb and helpless when confronted by this question, as has common sense. Much is told about the behavior of matter; how fast and far, and when it moves, and what is the result of its impact, etc.; all very interesting and highly useful information. But how anything behaves, what it does, is one thing; what it is is something entirely different. One is reminded of Dr. Johnson's definition of oats, as a grain eaten by men in Scotland and horses in England, except that he does class it as a grain.

Another familiar device of science is to divide and conquer; though in fact dividing does not itself succeed, but merely leads indirectly towards success. "No wonder," says science, "we have not found out what matter is, for matter is very deceptive, and is not at all what it seems. In fact and in truth matter is made up, not of the large bulks we see, but of minute particles, called molecules, in the neighborhood, for the simplest element, hydrogen, of one fifty-millionth of an inch in diameter, and these minute molecules are in turn made up of very much smaller particles, atoms, two to a molecule in some elements, many more than two in others. And observe, we can point out how the atoms are placed in the different molecules, and see how beautifully they shift their places in mystic dance when a chemical reaction occurs. *All* that happens in the intercourse of matter is at bottom but the interplay of atoms and of molecules. How wonderful is nature, and how searching the discoveries of science!"

All of which is true, indeed profoundly useful truth. For has not science transformed the face of the earth in an incredibly short time, a little over fifty years. And yet how much nearer are we to knowing what matter is when we discover how it is put together? If we ask what wood is, and are told that it is made up of tiny pieces of wood

put together thus and so, information, important information, it may well be, is given. But plainly our question is not answered, it is merely pushed a step farther back. In the equations of science, it would seem, matter is represented by an x, whose value is seldom sought. But with everything made out of matter, it is certainly worth the while to search out its intrinsic nature.

Possibly then, since common sense and science appear to be equally unable to say what matter is, the problem is beyond the scope of human powers. May be, as Lord Dundreary says, it is one of those things no fellow can tell. It may be so, but it is well to remember that the discoveries of science have nearly all been things that the faint-hearted said no fellow could tell. Besides, as regards the problem of matter, no philosophic generation has ever been wholly agnostic, and the foremost members of the present and latest scientific generation are not agnostic. And, moreover—a point of especial significance—it is well to remind ourselves that philosophers and scientists, in spite of the difference of their points of view, and of their methods, seem rapidly to be approaching agreement as to the nature of matter. It should then repay us to hear what they have to say.

Insisting, as we have seen, that sensations—colors, sounds, tastes and the rest, are not matter, or any part of matter, philosophers—at least those unconfused by Hume's oversophisticated attack on causes, taken so seriously by Kant—these philosophers, I say, maintain that sensations rightly studied tell us what matter is. Known directly, and indirectly as effects of matter working on our senses, sensations, critically considered, show matter to be a vastly complicated system of active causes, occupying space, that and nothing more.[2] Each material object is thus known to be a group of forces, more or less complicated in their interplay, and varied as to their constituent elements. The forces constituting a living cell are very varied in kind and complicated in interplay, as compared with those composing an equal volume of hydrogen gas; but complicated and varied forces are forces none the less. Moreover, all kinds of matter have one quality in common, the forceful defense of the space they occupy. This is called their solidity or impenetrability. Everything material opposes force to attempted encroachment on its space, and, unless given room elsewhere, absolutely prevents its entire appropriation; though all the forces of the universe pressed upon a single drop of water, it could not be annihilated. Thus impenetrability is the active defense of space. The fundamental constituent of matter is force.[3] And other constituents are the chemical, electrical and remaining physical activities, whose

[2] Nothing more so far as sensations of the special senses can help us to know the intrinsic nature of matter.

[3] Some would prefer the term "energy," others "activity." I know of no satisfactory term; but the thing denoted is *real*, many and baffling as are the mysteries it contains.

effects are more or less familiar. Nor need philosophers deny that matter is made up of molecules and atoms, or of electrons even, provided always these smaller and smaller particles are admitted to be bundles of forces, occupying less and less extended allotments of space.

Where this view departs from that of common sense, it is simpler, that is all. Common sense says matter is blue, sweet, soft, etc. No, say the philosophers, these are effects, not properties. Again, common sense says, and here with a shrill insistence, Force is not matter, but in it. No, say philosophers, there is no need of complicating with an irrelevant distinction. Force, activity, achievement, that is all there is to matter. As Heracleitus said 2,500 years ago, πανταρεῖ, flowing, change, *doing* is all.

Beyond question the blind force of our nature strongly inclines us to ask for more. But in obeying this prompting we are but worshipping an idol of the tribe, a fallacy patent enough as soon as the nature of the mind is understood. The insistence on something more than force in outer objects registers the triumph of the "imagination," a blind "faculty," as Kant rightly called it, unaware of its own contents, and of their significance, over clear-sighted and self-critical reason. Everything we talk of and think about, including matter, is identified, when necessary, and mentally dealt with, by means of its picture stored away in the imagination, which picture appears automatically when its aid is required. Without such counterfeit presentments the mind could not make a beginning of dealing with the objects about it, for their names are not pasted upon them, and besides, the mind is often concerned with them during their absence, and must then have a representative with which to treat. Now, most men picture matter chiefly in visual terms, though partly in terms of touch and muscular feelings, which last are so constantly aroused by the resistance of things. And the fallacy consists in clinging to the picture of matter, naïvely, uncritically, inaccurately constructed before reflection, out of our most familiar sensations, and in insisting that it correctly represents matter, although reason clearly demonstrates that sensations are no parts of matter, but only its effects. And the fallacy continues to impose on us because the picture works in subconsciousness, automatically registering dissatisfaction with force, as failing to fill out its notion of what matter is. As soon as we know that the picture of our imagination is formed during the early unthinking days of our ignorance, we know that it has no proper standing as against the critically tested conclusions of reason. But that does not check the dissatisfaction automatically suggested by the imagination, which philosophers feel in common with other men. The difference is that they disregard the feeling; they refuse to bow down to this idol of the tribe.

The same dynamic view of matter is reached by another avenue of approach, as is pointed out by students of the evolution of mind.

Probably the contribution of evolutionary theory to our knowledge of mind that bulks larger than any other is the discovery, growing clearer with each year of study, that the human mind also is fundamentally just a group of activities, greatly complicated, mysteriously unified, wonderfully resourceful, marvelously progressive, self-conscious, moreover, and free, and yet at bottom a system of activities, no more. Activity, doing, will, that is the core of us, the rest, sensation, feeling, idea, they are but the effects of our own or of other activities. A spirit, in etymology, is just the active principle of a liquid: and activity is what distinguishes the quick from the dead. Even superman, in his ascending excellence, we must believe to be but vaster and more skillfully and perfectly ordered activity. And man is distinguished from his humbler brethren, and higher animals from lower, by what they can do. Man hesitates, chooses, plans, contrives and fits things together in fulfilment of his purposes. As we descend the animal scale these activities first diminish, and then disappear, dull routine taking their place. But this implies, not a substitute for activity, merely its simplification. And the same decrease of complexity obtains as the transition is made from animals to plants, and from plants to inorganic matter. This no doubt seems a hard saying to those who have not followed discoveries and discussions in this field; but to those who have it is little more than a commonplace. We do not yet know how inorganic activities become systematized into organic, or what determines their form as vegetable or animal. The cell still keeps its secret. But that inorganic is transformed into organic is plainly shown by every breath taken, every meal eaten, and every development of an embryo to maturity, as the reverse transition is shown by all waste processes, including death itself. As men organize themselves into states, and lesser associations, which have organs and modes of activity which no man has, so, it would seem, molecules organize themselves into cells, and cells into living beings, which differ even more in structure and function from the units composing them.

In substance, then, comparative psychology teaches that a man is a complicated system of activities, sensitive and conscious; an animal a less complicated system, sensitive and conscious; a plant a still less complicated system, sensitive, but only dimly conscious, if at all so; and organic matter, the simplest system of activities we know, whether either sensitive or conscious we are not yet prepared to say. So much is quite plain. But all is not said. It is also plain that inorganic, or so-called dead matter, has, in the way of evolution, developed into organic or living matter, and that matter is being daily transformed into living, yes, into conscious, beings, and living and even conscious beings are being daily transformed back into mere matter. These plain facts of themselves throw not a little light on the nature of matter. For they show that the constitution and the nature of matter

must be such as to allow of the development and interchange discovered. Matter can not be very dead, it can not be blankly non-conscious, it would seem, if everywhere and at all times it is, in the ordinary routine of the world, nourishing and stimulating life and consciousness, which in their turn dissolve into mere matter in the same normal way.

Such, too briefly and imperfectly stated, are the contributions of philosophy, and its component and ancillary sciences, to our knowledge of matter. Next we turn to the physical sciences themselves, physics, chemistry and new-born chemico-physics, and find, as will presently appear, a singularly impressive confirmation of the results set forth. This should not surprise us. It merely adds one more to the many instances where philosophy's reasoned conclusions have proved prophetic of the more concretely reached results of experimental science. The former, glancing over the promised land throughout its broad extent, spies out its prominent landmarks, and sets them up as goals to guide the slow and laborious but sure occupation which it falls to the lot of the latter to undertake. Each task yields its own delights, and each performs its peculiar service. Where both are indispensable, only the cramped mind will seek to belittle either.

Nearly two and a half centuries ago, in 1658, to be accurate, Boscovich, the great Italian administrator, diplomat and physicist, set forth and ably defended the view that atoms are but forces, each concentrated in a mathematical point, and held apart by their mutual repulsions. The view did not fail of its adherents, numbering among them names as great as that of Faraday. But even if the prejudices of an imaginative race had allowed it a fair hearing, which they did not, the state of science was not ripe for the general acceptance of the theory. Electricity did not exist for science, and countless hours of research had still to be labored through before a sufficient weight of experimental facts could be accumulated to outbalance our tribal idol. So stiff-necked is an inborn bent of human nature. Besides, Boscovich delayed the triumph of his theory, in its essential principle, in my judgment, by confining his force atoms to mathematical points, and denying them spatial occupancy, the fundamental attribute of matter: a course the more to be regretted, as the denial is unnecessary, indeed contrary to plain experience.

The status of Boscovich's theory, and its more or less modified successors, remained practically unchanged till the end of the nineteenth and the marvelous beginning years of the present century, a few of the best minds of each generation upholding it, but the large majority of physical scientists, including men of unsurpassed eminence, according it a neglect more or less contemptuous. But these recent years have been bringing about a change. A number of physicists of the first

rank are aggressively championing the dynamic theory of matter, and as each unexpected discovery, hurrying upon the heels of its predecessor, brings support to the theory, its opponents seem conscious of engaging in a losing fight.

Before passing to the chief evidence, I will just mention some curious experiments of the Hindu physicist, Dr. Bose, a professor in Calcutta University, which indicate the trend of the more advanced research that is now being prosecuted, and indirectly support the dynamic theory, by tending to show that metals, at least, are not dead, but alive, bundles of activities like living animals. Dr. Bose's book, "The Response of Matter," I have not been able to secure; the quotation that follows is from a notice of it in the London *Review of Reviews*. Dr. Bose's discovery is, that stimulated metals give back, under proper conditions of observation, the electric response that has been thought peculiar to, and characteristic of, organic or living matter, and, with variation of conditions, vary their response just as organic matter does:

> When the metals were stimulated by a pinch they also made their autographic records by electric twitches, and thus, being responsive, showed that they could in no sense be called "dead"! Nay, more, it was found that given the records for living muscle, nerves and metals, it was impossible to distinguish one record from another. For the metals also, when continuously excited, showed gradual fatigue; as with ourselves, so with them, a period of repose revived their power of response—even a tepid bath was found helpful in renewing vigor; freezing brought on cold torpidity, and too great a rise of temperature brought heat rigor. . . .
>
> Death can be hastened by poison. Then can the metals be poisoned? In answer to this was shown the most astonishing part of Professor Bose's experiments. A piece of metal which was exhibiting electric twitches was poisoned; it seemed to pass through an electric spasm, and at once the signs of its activity grew feebler, till it became rigid. A dose of some antidote was next applied; the substance began slowly to revive, and after a while gave its normal response once more.

But it is not upon such experimental curiosities that the dynamic theory of matter is based, significant as they may be of the future discoveries of science. It is more substantially founded upon the evidence of the spectroscope, the fast-growing knowledge of electricity, and the marvelous results of the experiments on radio-active substances. Recent publications have made these facts familiar, and it will only be necessary to recall them briefly, grouping them in such wise as to suggest their significance as clearly as possible.

There has been a disposition among scientists for the last half century, growing constantly stronger, and finally becoming nearly irresistible, to look upon Dalton's atoms as divisible, therefore misnamed, and not the ultimate constituents of matter. Suspicion was first cast upon their simplicity and ultimateness when the spectroscope disclosed several distinct lines in the spectrum of each element; and was reinforced when it appeared that some elements had two or even three distinct spectra. Nor was the case bettered when it was found that

many of the lines in the spectra of hydrogen, calcium, iron and other elements are missing when the light from very hot stars is broken up. For the inference is right at hand, as Professor Bigelow says, "that at extreme, at stellar, temperatures our elements themselves are dissociated into simpler substances."[4]

Further evidence against the atom resulted from Professor J. J. Thomson's studies of cathode rays, strict reasoning from his careful experiments demonstrating them to be swarms of minute particles, or corpuscles, as he called them, moving with velocities approaching that of light, and each weighing about one eight-hundredth as much as a hydrogen atom. These corpuscles are not merely ordinary atoms of smaller bulk, for they do not obey chemical laws, it having been ascertained, among other things, that the absorption of them by different substances is simply proportional to the latter's specific gravity, and quite independent of their chemical properties.

And recently the case against the atom, together with Thomson's ingenious demonstration of his corpuscles, has secured further experimental foundation, thanks chiefly to the labors of Becquerel, the Curies, and Rutherford and Soddy, on radioactive substances. These wonderful experiments, at once rapid and reliable, have shown that radioactivity consists in the throwing off of two orders of substances: first, atoms; second, rays or corpuscles of various kinds. But the remarkable fact in the situation is that while the atomic weight of the original substances, radium, thorium and uranium, is two hundred or more, the weight of the atoms thrown off is nearer one or two. That is, radium breaks up into, probably, helium, thrown off, and the residuum after the emission, which has a different atomic weight from either and is otherwise shown to be a distinct element.[5] The dream of the alchemist has come true and elements are transmuted before our eyes. Science has achieved an unsurpassed triumph! But, as far as helping us to fortune goes, the dream might as well have remained a dream.

As a result of these discoveries, and many others similar, in general, in significance, it has come to be admitted that Dalton's atoms are very complex bodies, each made up of a large number of corpuscles, which are related to one another very much as are the members of a planetary system, though in size corpuscles are unimaginably minute, and the number of them constituting any atom is very much larger than the number of members in any planetary system with which we are acquainted.

[4] POPULAR SCIENCE MONTHLY, July, 1906.

[5] In a communication to *Nature*, July 18, copied in *Science*, August 2, Sir Wm. Ramsay states that copper, in the sulphate, acted upon by the emanation from radium, was "'degraded' to the first member of its group, namely, lithium." The substance of the quotations that appear later in this paper could be found repeated many times in the writings of Thomson, Ramsay and others of the new school at home and abroad.

With atoms broken up into corpuscles, the problem of the nature of matter shifts one step farther back, and becomes the problem of the nature of these tiny bodies. Of this problem two rival solutions are now in the field, offered respectively by the conservatives and the liberals. The former, while admitting that a corpuscle is in the main an electric charge, or field of electric force, maintain that the charge has a nucleus or carrier at its core, which alone is entitled to be called matter, in distinction from the electricity of the charge. Lenard, who has given to corpuscles the significant name of dynamides, has calculated the diameter of this center of actual matter, so called, and found it to be smaller than 0.3 of 10^{-10}, *i. e.*, smaller than three hundred thousand millionths of a millimeter. This means that the actual matter, so called, of a cubic meter of so heavy an element as platinum, occupies at most one cubic millimeter of space, the rest of the cubic meter being empty of Lenard's matter, and in fact entirely empty of ponderable matter, but for the electric charges.

With so much of matter acknowledged to be electric force, which to that extent successfully performs all the functions which used to be attributed to matter, it is natural, say the liberals, to inquire whether the whole of matter can not be reduced to force, whether matter is not just force and nothing more. Many facts, they say, make this altogether the more probable, indeed the only comprehensible, hypothesis.

In the first place, as Sir Oliver Lodge, who shares with Professor J. J. Thomson—another hard-headed Englishman—the distinction of leading the liberals, points out, "an electric charge possesses the most fundamental and characteristic property of matter, *viz.*, mass or inertia."[6] If the charges occupying a given space are sufficient, and their potential is sufficiently high, their combined mass will equal, and exhaustively account for, the observed mass of the matter occupying the space. This conclusion was theoretically established long since, and has recently received experimental confirmation from laboratory studies on radio-activity.

On these points, I quote the statement of Professor Bigelow, of the University of Michigan:

> Long before experimental evidence of the existence of corpuscles had been obtained, it was demonstrated that an electrically charged body, moving with high velocity, had an apparent mass greater than its true mass, because of the electrical charge. The faster it moved the greater became its apparent mass or, what comes to the same thing, assuming the electrical charge to remain unaltered, the greater the velocity the less the mass of the body carrying the charge needed to be to have always the same apparent mass. It was calculated that when the velocity equalled that of light, it was not necessary to assume that the body carrying the charge had any mass at all! In other words, the bit of electric charge moving with the velocity of light would have weight and all the properties of mass.
>
> This might be looked upon as an interesting mathematical abstraction, but

[6] POPULAR SCIENCE MONTHLY, August, 1903.

without any practical application, if it were not for the fact that Kauffmann determined the apparent masses of corpuscles shot out from a radium preparation at different velocities, and compared them with the masses calculated on the basis that the whole of the mass was due to the electric charge. The agreement between the observed and calculated values is so close that it leads Thomson to say: "These results support the view that the *whole* mass of these electrified particles arises from their charge."

Then the corpuscles are to be looked upon as nothing but bits of electric charges. . . . It is this view which has led to the introduction of the term electron. . . . We have but to concede the logical sequence of this reasoning, all based on experimental evidence . . . and we have a universe of energy in which matter has no necessary part.[7]

Facts as many and as significant as these, added to the reasoned conclusions of philosophy and psychology, would seem adequate to settle the controversy in favor of the dynamic theory of matter, were it not that we are dealing with an idol of the tribe, far more difficult to shatter than the golden calf. But more remains to be said. The validity of a hypothesis rests not only upon the facts that support it, but also upon the ability it gives us to explain puzzles in fields adjacent to its own. This makes it worth while to mention, though space will not allow explanations in detail, that a number of knots in physical theory, that before had to be cut or else left alone, can be handily untied by the dynamic hypothesis. Professor Bigelow is again my authority in the statements, that the theory explains the highly puzzling property of valence, and that "An electronic structure of the atom furnishes a basis from which a plausible explanation of the refraction, polarization and rotation of the plane of polarized light may be logically derived."[8] These explanations bulk large in the aggregate, and the exclusive ability of the dynamic theory to make them adds significantly to its credibility.

As an alternative to the dynamic theory, thus substantially supported, the conservatives have little to offer, indeed, in the last analysis, nothing but a word. The "matter" they refuse to identify with force shrinks down to John Locke's "something, I know not what," by which a portion of the mass of bodies is to be accounted for. But, Sir Oliver Lodge remarks, "it would be equally true to say unaccounted for. The mass which is explicable electrically is to a considerable extent understood, but the mass which is merely material (whatever that may mean) is not understood at all."[9] "What is this matter which so many insist we must assume?" Bigelow asks, and answers:

No man can define it otherwise than in terms of energy. . . . Starting with any object and removing one by one its properties, indubitably forms of energy,

[7] POPULAR SCIENCE MONTHLY, July, 1906. Instead of conceiving matter as explained away, energy taking its place, I prefer to conceive of it as *explained as being* energy and nothing else. This difference in terminology is unimportant, but might lead to confusion if not pointed out.

[8] *Loc. cit.*

[9] *Loc. cit.*

we are finally left with a blank, a sort of hole in creation, . . . The last resort is the time-honored definition, "matter is the carrier of energy," but it is impossible to describe it. The assumption that matter exists is made then because there must be a carrier of energy. But why must there be a carrier of energy? This is assertion, pure and simple, with no experimental backing.[10]

When solidity, and mass or inertia are adequately explained as dynamic facts, and many puzzling physical facts are similarly accounted for, it is surely superfluous to seek further explanation in something more to be called matter, especially when no man can tell or ever has told us what he means by the word.

This is not the place to set forth what we know about electric charges, but some mention should be made of the unification introduced into our knowledge by accepting these minute bodies as the building stones of the grosser structures more immediately experienced.

A word first as to their size:

We are sure, says Lodge, that their mass is of the order one thousandth of the atomic mass of hydrogen, and we are sure that if they are purely and solely electrical their size must be one hundred thousandth of the linear dimensions of an atom: a size with which their penetrating power and other behavior is quite consistent. Assuming this estimate to be true, it is noteworthy how very small these electrical particles are, compared to the atom of matter. . . . If an electron is represented by a sphere an inch in diameter, the diameter of an atom of matter on the same scale is a mile and a half. Or if an atom of matter is represented by the size of this theater [the Sheldonean], the electron is represented on the same scale by a printer's full stop.

He proceeds a little later:

It is a fascinating guess that the electrons constitute the fundamental substratum of which all matter is composed. That a group of say 700 electrons, 350 positive and 350 negative, interleaved or interlocked in the state of violent motions so as to produce a stable configuration under the influence of their centrifugal inertia and their electric forces, constitute an atom of hydrogen. That sixteen times as many, in another stable grouping, constitute an atom of oxygen. That some 16,000 of them go to form an atom of sodium: about 100,000 an atom of barium: and 160,000 an atom of radium.

On this view all elements would be regarded as different groupings of one fundamental constituent. Of all the groupings possible, doubtless most are so unstable as never to be formed; but some are stable, and these stabler groupings constitute the chemical elements that we know. The fundamental ingredient of which, on this view, the whole of matter is made up, is nothing more or less than electricity, in the form of an equal number of positive and negative electric charges.

This, when established, will be a unification of matter such as has through all the ages been sought: it goes further than had been hoped, for the substratum is not an unknown and hypothetical protyle, but the familiar electric charge.[11]

[10] *Loc. cit.*

[11] POPULAR SCIENCE MONTHLY, August, 1903.

And having gone thus far, we can not escape going farther. For two or more atoms, properly related, form molecules; these groups of forces, aggregated in large numbers, form, on the one hand, masses of inorganic matter, and, on the other, living cells; and the last, in turn, organize themselves into living, and ultimately into conscious and rational, beings, who, in the last resort, are vastly complicated activities, aware of, and, in a measure, controlling their own intricate behavior.

To an active imagination the dynamic theory opens up fields fascinating to contemplate. Look first at the practical side. Aside from energy of gross position and molar motion, we are accustomed to think of heat and other forms of chemical energy as the only ones available for human use. But Wetham tells us that:

> As a mean value, we may say that, in mechanical units, the energy available for radiation in one ounce of radium is sufficient to raise a weight of something like ten thousand tons one mile high.

And later that:

> The energy liberated by a given amount of radioactive change . . . is at least 500,000 times and may be 10,000,000, greater than that involved in the most energetic chemical action known.

Admitting that our coal measures and iron mines may in time give out, it is evident that the present generation need not feel greatly alarmed. For who will deny to ingenious man the ability to harness these literally stupendous new forces as he has their weaker predecessors?

And on the theoretical side the gain is no less great. A respectable hypothesis, which experimental, and even laboratory methods can test, correct and enlarge, as growing experience demands, can, even in its initial form, give unity to our thinking. It not only reduces the independent chemical elements to brotherhood in the one mother substance, but it renders matter, as essentially activity, homogeneous with active mind, thus freeing us from the hopelessness of dualism, and giving a monistic view of the whole of things. And nowhere is utter death to be found. The universe, active through and through, comes out from under the heavy hand of rigid mechanism. Spontaneity is at its heart, and in the marrow of its bones. But lawless and chaotic it is not. There is regularity in the operation of its minutest parts, and organization, harmonious coworking is the law of its being, from the cooperative union of electrons into atoms to the organization of men into societies, and possibly farther still. But the order and harmony are not imposed from without by an alien power; as the laws of children's play, they are the natural rules of behavior of spontaneous beings, following, unhampered by others besides themselves, the promptings of their interacting natures.

FARM TENANCY A PROBLEM IN AMERICAN AGRICULTURE

By Professor HOMER C. PRICE
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THE per cent. of American farms operated by owners is constantly decreasing. The census for 1900 shows that over one third of the farms are operated by tenants and that in the last twenty years the per cent. has risen from 25.5 in 1880 to 35.3 in 1900.

This tendency toward tenancy has been and is viewed with alarm by the thoughtful American farmer. One of the boasts of American life has been the independence of ownership of its people. American agriculture in particular has been made up of a class owning their own farms. Land has been in greater abundance than labor or capital and has been dealt out with a lavish hand by the government. Since 1863, 233,043,939 acres of land have been given away in homesteads of 160 acres each, under the "Homestead Act" of 1862. For the man who wanted a farm there has been an opportunity to get one for taking it up and establishing a home. And the distribution of this land has not been confined to any one year, but quite uniformly distributed throughout the last forty years, and since 1900 more land has been given away by the homestead entries than ever before, as shown by the following statistics:

Public Lands of the United States taken up in Homestead Grants since 1900

Year	Acres
1900	8,478,400
1901	9,479,275
1902	14,033,246
1903	11,193,120
1904	10,171,266

With these large areas of public lands being given away each year, and with a farming population that is constantly decreasing as compared with the population engaged in other occupations, why should the farmers of our country be losing the titles to their farms? Is it a harbinger of an American peasantry, and are we drifting toward landlordism? When compared with European countries, the United States is neither first nor last in the matter of tenancy of her farm lands. In Germany 12.38 of the farm lands are cultivated by tenants, in England 86 per cent., in France 47.2 per cent. and in the United States 23.3 per cent. of the *total* farm lands.

The distribution of this tenancy in the United States varies greatly, depending upon geographical location.

TENANCY AND LAND OWNERSHIP IN THE UNITED STATES IN 1900

	Owners	Tenants
North Atlantic States	79.2	20.8
South Atlantic States	55.7	44.3
North Central States	73.1	26.9
South Central States	51.4	48.6
Western States	83.4	16.6

The southern states have by far the largest amount of tenancy, which is due, no doubt, in a large degree to the negro population. When the slaves were freed, the large plantations were broken up and instead of the system of slavery there sprang up the system of tenancy which, from the standpoint of economic production, has been worse than slavery, and the lands have been depleted of fertility and have produced a scanty living for both the tenant and the landlord, whereas under the old system they would have produced an abundance for owner and slave, and their fertility would have been maintained.

In the northern states the conditions are different—and other causes have entered into the problem of land ownership. In the North Atlantic states, characterized by their granite hills and sterile soils, the problem of tenancy has not been as great as the problem of abandoned farms. Farms were deserted because no one could be found to rent them and owners stayed on them because they could not sell them. The young men have gone west, to the more fertile lands, and allowed the farms to revert back to nature. Within the last few years, the high prices that have prevailed for farm lands in the middle west have created a demand for the abandoned farms of New England, and many of them have been taken up.

Economists claim that tenancy is a step toward ownership, and that the young man who purchases a farm is first a renter and then a farm owner. If such is the case, the state of tenancy is but temporary, and an increase of tenancy would be indications of prosperity, and would simply mark a step in the process of acquiring land ownership. But, if this is the case, the per cent. of farms held by tenants should not continue to increase indefinitely, but should soon begin to decrease—however, this is not the case, and more American farms are constantly going into the hands of tenants.

For a closer investigation of this subject let us take the state of Ohio, which is typical of the North Central states. In 1880 the per cent. of tenancy in Ohio was 19.3, in 1890, 22.9, and in 1900, 27.5. The state is naturally divided into four distinct agricultural divisions. The northeastern part of the state is made up of more or less rolling land, and a soil that is largely clay or clay loam. The soil is adapted to dairying and the growing of wheat, oats, timothy and pasture, but not to corn. The southeastern part of the state is made up of the non-

MAP OF OHIO SHOWING THE PER CENT. OF FARMS OPERATED BY TENANTS AS REPORTED IN THE TWELFTH CENSUS 1900.

glaciated part of the state and is preeminently hilly and sterile, and is by far the poorest agricultural section of the state and contains the lowest-priced land in the state. The southwestern part of the state embraces the Miami river valleys and is made up of the most fertile and valuable agricultural lands of the state. The northwestern section of the state is made up of the newest lands in the state, principally level lands that have necessitated draining, but after being reclaimed have proved to be exceptionally fertile lands.

On the accompanying map, showing the per cent. of tenancy in each county in the state, as reported in the twelfth census, it will be seen that the largest amount of tenancy is to be found in the southwestern section of the state, in the Miami river valleys, and the most fertile section of the state; and, if the accompanying map showing the decennial valuation of lands in the state as reported for taxation is also compared, it will also be seen that there is a close relationship between

MAP OF OHIO SHOWING THE VALUATION OF FARM LANDS PER ACRE, BY COUNTIES, AS REPORTED BY THE DECENNIAL BOARD OF APPRAISERS IN 1900.

the values of land and the per cent. of tenancy. That is, the highest per cent. of tenancy is to be found on the most fertile land. It is not because tenancy tends to increase the fertility of the land or to increase its valuation, because such is not the case, but rather the opposite. But it is due to the fact that the more fertile lands are the best investment for capital and are more eagerly held as investments than any other farm lands. In the fertile counties of the state, where the percentage of tenancy is high, farms that have been inherited by children who have gone to the city to live have been held as investments. They are readily rented, so that they will yield a fair return on the investment, and at the same time the sentiment of keeping the old homestead is observed. In this way they are rented out for cash, or a share of the crops produced, and they thus pass into tenancy. On the less fertile lands of the state, such as are found in the southeastern part, the per cent. of the farms held by

tenants is low, and the value of the farm lands is low. The lands are poor investments for capital, and farms inherited by parties no longer living in the section are turned into money as quickly as possible. Loose capital will not go into such territory and buy such farms just as an investment. The same principle holds true in a comparison of the states as of the counties. In the North Central states the average tenancy of farms was in 1900, 27.9 per cent. By states it was as follows:

	Per Cent.
Illinois	39.3
Nebraska	36.9
Kansas	35.2
Iowa	34.9
Missouri	30.5
Indiana	28.6
Ohio	27.5
South Dakota	21.8
Minnesota	17.3
Michigan	15.9
Wisconsin	13.5
North Dakota	8.5

Illinois and Iowa are acknowledged the best agricultural states in the union, as well as in the North Central division, and hold first and fourth place, respectively, in this group of states—the great agricultural states of the union. Our most fertile lands are gradually drifting into the hands of tenants, and unless the movement is stayed the agriculture of these farms will decline.

Tenancy, as it now exists on American farms, is detrimental to the agricultural welfare of the country, from both an economic and a social standpoint. Farm leases, as a rule, are of short duration; this is an incentive to the farmer to only have regard for the present productiveness of the land and to disregard any methods of maintaining the fertility of the land. Short leases result in a transient population that is demoralizing to the farmer himself and to the community. The old proverb, "A rolling stone gathers no moss," is no more aptly illustrated than in the case of the tenant farmer who moves from farm to farm, never remaining more than a few years in a place. Such a tenant is not interested in improving the farm unless immediate results can be realized; he is not a permanent citizen of the neighborhood and can not be regarded as a reliable constituent of the school or church. Absent owners of such farms are not interested in the improvement of the buildings and equipment of the farms, the building of better roads, the maintaining of better schools or any public improvement that will add to the expenses of the farm unless it will give a proportionate return at an early date.

In England the detrimental effects of farm tenancy that have been mentioned are in a large degree removed by the long periods which tenants occupy the same lands; father, son and grandson occupy the same farm throughout their lifetime, and the land owners are satisfied with a low per cent. of interest on their investment and have no thought of changing their tenants. Under such conditions there is little chance for a farm tenant to become a farm owner, and, in most cases, little desire.

In the north central states of the United States it is becoming more difficult for the farm tenant to become a land owner; prices of farm real estate have advanced so that it is becoming more and more difficult for the farm hand to own a farm. On the other hand, the present farms are passing from father to son by inheritance, and why should the per cent. of farms operated by owners decrease if one son in each family remained on the homestead, or one daughter in each family married a farmer and took up the management of the homestead?

Senator Morrill in his speech before congress in behalf of the land grant colleges, in 1858, said that, "The nation which tills the soil so as to leave it worse than they found it is doomed to decay and degradation." When these words were uttered, there seemed to be an endless expanse of public lands that only awaited the pioneer's plow to yield their virgin fertility; these lands have now been practically all taken up, and it is doubly important that the fertility of our soils should be preserved. The very fact that tenancy of farm lands tends to deplete their fertility is sufficient reason for a general interest in the subject.

Much has been written and said about the movement from country to city, and many causes have been assigned for it, but it has been the natural result of the introduction of labor-saving machinery and improved means of transportation, and fewer persons are required to carry on agriculture than formerly. However, this does not account for the decline in farm owners, and the problem still remains.

Legislation can do something to make it easier to own land than at present. The removal of taxes on mortgaged farms, the establishment of a better credit system, so that money can be borrowed more readily and more cheaply for the purchase of farm lands than is the case at the present time, would greatly add to the ability of young farmers buying their own farms.

Education that will teach a more rational system of agriculture and a greater appreciation of the possibilities of the farm and farm life will do much to counteract the tendency of farm boys to leave the farm lands that they have inherited to seek employment in the city.

SOME RECENT TRANSMUTATIONS[1]

By Professor CHARLES BASKERVILLE
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IT would prove of little general profit to review the elaborate alchemical literature of the nineteenth century. It may be stated that in 1832 Schneider published in Halle a history of alchemy accepting the transmutation of the metals as accomplished by those aware of the necessary procedures. The study of alchemy prospered in France,[2] although it has generally been considered that the new chemistry, beginning, as it were, with Lavoisier, put down absolutely the probability of the transmutation of the metals. The affairs of the Alchemical Association of France, the successor of the Société Hermetique, founded by Albert Poisson, are controlled by the secretary-general, assisted by seven councilors, who hold an annual meeting. Numbered among the honorary members are the astronomer, Flammarion, and August Strindberg,[3] a Swedish resident in Austria.

Although Marignac[4] acknowledged that the habitual association in nature of groups of elements, as for example titanium, tantalum and columbium, offered one of the strongest proofs that can be found for the community of their origin, it is of conservative interest to observe that von Meyer, in that charming "History of Chemistry" of his,[5] says: "The final echoes of the alchemistic problem which had for so long a period of time held the cultured of every nation in a state of tension, and had even blinded eminent scientific men, only appear to die away during the last decades of the nineteenth century." This statement remains in the last edition of his book (1906), in which are recounted the discoveries of radioactive bodies and the transformations of the emanation coming from those unique substances.

We are well aware that the problem of transmutation of the elements is not solely of academic interest from the legends, courageous, tragic, fantastic, ludicrous or iniquitous, that have been handed down. Motives characterized by harsher terms than selfishness are usually attributed these days to those who apply themselves to changing the

[1] Read before the New York Section of the American Chemical Society, October 11, 1907.

[2] See Baudrimont, "Traité de Chimie," Paris, 1844.

[3] See "Introduction a une Chimie Unitaire," Paris, 1895.

[4] *Archives des Sciences Physiques et Naturelles*, **17**, 5; *Chemical News*, **56**, 39.

[5] Page 64; see also Kopp's, "Die Alchemie in alterer und neuerer Zeit."

bountiful metals into our agreed standard of exchange, for, as a rule, such are thought, with and without reason, to be in no position to give adequate return for money advanced to perfect the methods which investors are assured will produce the desired results. Especially is this true of the possessor of so valuable a secret, who may alone soon place himself beyond financial concern through the agency the knowledge, which he seeks to share with a few preferred ones.

At the corresponding meeting of this section just ten years ago, my friend, the late Dr. H. Carrington Bolton, presented a paper on this subject,[6] dealing specifically with the publications of S. H. Emmens, of New York.

It has long been known that golden-yellow specks would occasionally show themselves in silver solutions, but could not be obtained at will. Probably this phenomenon has often led to a supposition that silver might be transmuted into gold. Silver can be converted wholly into this form by the reduction of silver tartrate by ferrous tartrate. The solutions must be rather dilute and must be freshly prepared. A red powder is precipitated; this changes to black, and on the filter has a bronze color. After washing, it is removed in a pasty condition and allowed to dry spontaneously. This form of silver is very permanent when dry. It dries into lumps resembling polished gold. By brushing a thick paste of this substance over clean glass, beautiful gold-colored mirrors are obtained. The stronger acids, even when much diluted, instantly convert this allotropic form of silver into normal gray silver; this is also effected by means of pressure.[7]

Using Lea's method, just described, as a starting point, Emmens[8] thought to extend Andrew's doctrine of critical temperatures. By "the combined effect of impact and very low temperature," the former being produced by his force engine, a substance was obtained which was claimed to be common to both gold[9] and silver, hence the name argentaurum. One ounce of silver was said to produce three quarters of an ounce of gold. It was stated that the chief source of expense incurred was in the time required for bringing about the desired molecular changes. A profit of at least $3 per ounce on all silver used was assured, however.

Sir William Crookes did not succeed, to his satisfaction, in repeating the work, although Dr. Emmens stated that during that year Dr. Cabel Whitehead, assayer to the mint in Washington, accepted six ingots of the alloy, approximately a thousand dollars in value.

[6] *Chemical News*, **76**, 61.

[7] "Gold-yellow and Copper-colored Silver," M. C. Lea, *Chemical News*, 1889, **60**, 54.

[8] Papers by John MacKenzie in the *Spokane Mines and Electrician*, February 17, 1898; and Bolton, *Chemical News*, **76**, 61.

[9] Efforts on the part of the writer at the time failed to secure samples of argentaurum from Dr. Emmens.

It may not be amiss here to state that a severe criticism of Emmens's "Argentaurum Papers" appeared in SCIENCE the same year, written by Dr. R. S. Woodward. The libel suit instituted against the critic and Dr. J. McKeen Cattell, the "responsible editor," however, never came to issue.

A number of cases are on record illustrating the methods pursued in selling secret processes for the manufacture of gold. Accounts of many of these are in my possession as a result of the assiduous search on the part of my private assistant, Mr. W. A. Hamor. A recounting of them is scarcely suitable here. Suffice it to say, that a careful analysis of the motives actuating and methods pursued presents merely an inferior picture of the perfected practises we are gradually learning of as obtaining in that circle termed "high finance."

Among many communications reaching the writer, one is of more than passing interest. Mr. R. M. Hunter, of Philadelphia, has written concerning "synthetic gold" as follows:

> I have so perfected the process that in my judgment, based upon my actual experience, gold may be manufactured at enormous profit, and to this end I have designed a plant to be erected in Philadelphia and am at this moment negotiating for the $500,000 capital for its erection. I realize that the public and most scientific men are adverse to belief in the possibility of such an enterprise, but I know what I am doing and can afford to allow public sentiment to follow its own course.

Enclosed with the letter was an affirmative affidavit. On request, Mr. Hunter promptly forwarded me samples of silver in which the gold is "growing" and some "grown-up" gold, said to have been produced by his secret process. I have not made analyses of the samples, which are here exhibited.

Any discussion of the transmutation of the elements must involve a clear understanding of what we mean by the term element. By agreement, chemists regard an element as a substance which shows a characteristic spectrum and a definite combining weight. That such characterization is inadequate, that the ground upon which the characterization is founded may be shifting sand, and not the firm rock we are wont to liken it to, need not involve the present topic, as the agreed basis suffices for our purpose.[10]

Work on transmutation has by no means been limited to efforts to prepare the noble metals. Fittica's[11] investigations on the action of ammonium compounds on phosphorus in the presence of air led him to the conclusion that a true transformation of phosphorus into arsenic takes place, and that arsenic appears to be a nitro-oxygen compound of phosphorus, namely, PN_2O. The formation of arsenic from phos-

[10] These matters are thoroughly discussed in a forthcoming work by the writer from the press of John Wiley and Sons.

[11] F. Fittica, *Leopoldina*, **36**, 40; *Chemiker-Zeitung*, 1900, **24**, 483; *Chemical News*, **81**, 257.

phorus appeared to be accomplished best under proper temperature conditions, according to the following reactions:

$$2P + 5NH_4NO_3 = (PN_2O)_2O_3 + 10H_2O + 3N_2.$$

This is contrary to Flückinger's results on "black phosphorus," as the latter regarded this modification as arsenic, it is true, but considered that the phosphorus contained arsenic. Although Fittica claimed that his phosphorus was arsenic-free, Winkler[12] asserted that this could scarcely be the case, according to the work of Wittstock[13] and Hjelt.[14] The reaction should be written as follows:

$$2P + 5NH_4NO_3 = 2H_3PO_4 + 7H_2O + 10N.$$

Undaunted, Fittica[15] maintained that by varying the conditions antimony, as well, could be produced from phosphorus. As the result of the criticisms of Gyzander,[16] Noelting and Feuerstein,[17] Christomanos,[18] Gerack,[19] Arnold and Murach[20] and Councler[21] Fittica's case has been regarded as not proved.

With the discovery of the Becquerel rays, eventuating in the isolation of radium compounds by the Curies, lines of investigation were opened up leading to truly remarkable disclosures. According to the agreement, certainly radium may be regarded an element, as it has a characteristic spectrum and well-defined atomic weight as recently verified by Madame Curie.[22]

Radium compounds give off an emanation, a gaseous body, as discovered by Rutherford. Ramsay assigns it an atomic weight of 216.5, but no definite spectrum has been assigned the emanation, although it has been plotted by Ramsay and Collie. Rutherford and his associates have shown that the emanation passes through a number of changes giving Radium-A, Radium-B, etc. So far, definite atomic values and spectral data have not been obtained for these transitory disintegration products of the emanation. The lives of some of them are very short. The greatest dignity we may assign them is meta-element.

The formation of helium from the emanation was first shown by

[12] *Berichte*, **33**, 1693 (1900).
[13] *Poggendorfs Annalen*, **31**, 126.
[14] *D. P. J.*, **226**, 174.
[15] *Chemiker-Zeitung*, **24**, 561 and 991.
[16] *Chemical News*, **82**, 210.
[17] *Berichte*, **33**, 2684.
[18] *Chemiker-Zeitung*, **24**, 943.
[19] *Chemiker-Zeitung*, Repert, **24**, 274.
[20] *Chemiker-Zeitung*, **25**, 131.
[21] *Ibid.*, **25**, 977 and 1029.
[22] *Chemical News*, **96**, 127 (1907).

Ramsay and Soddy, and later confirmed by Indrikson, by Débierne, by Curie and Dewar, by Giesel and by Himstedt and Meyer. Hèlium, a conventional element which is devoid of any evidence of chemical affinity, is produced by or from radium, a conventional element, but the most active substance known. This occurs when the emanation is dry, and we have reason for assuming that the emanation may in reality be an active allotropic form of helium, as ozone is of oxygen.

Recently we have been thoroughly aroused again by Ramsay, who in collaboration with Cameron[23] has not only verified the above statement, but proved that when the emanation is allowed to traverse its downward career in the presence of water, neon and not helium is the gas produced. If the degradation of the emanation be in the presence of a solution of a pure copper salt, sulphate or nitrate, argon and no helium is produced. The emanation becomes one conventional element or another, dependent upon its environment. Helium, neon and argon, with the respective weights, 4, 20 and 40, are produced from the supposititious allotrope of the one with the lowest atomic weight.

We know of no case in which any one of these three obtained from other sources has been converted into the other; nor have we been informed as to whether or not the neon and argon thus produced from the emanation subsequently change into helium.

In this connection it may be stated that Meigen,[24] calling attention to the amount of energy set free in the formation of helium—about 10^9 great calories for a gram-atom of helium—states that any attempts at reversing this process are rendered hopeless. Nothing is hopeless in science. In fact, many of Ramsay's most fruitful researches have been in the investigation of the unlikely. Can it be, on the other hand, however, that the emanation is in reality a compound of these gases which are characterized by their inertness? Those who have worked with compounds of the rarer elements well know that their scission follows one direction or another, dependent upon ever so slight variations in procedure. If the emanation be, in fact, a compound, which is not likely, it is an endothermic compound involving energy with an order of magnitude far beyond anything with which we are familiar in ordinary chemical reactions. The total heat given off by one cubic centimeter of emanation is equal to about ten million gram calories, or nearly four million times as much heat as produced by the explosion of 1 c.c. of hydrogen and ½ c.c. oxygen.

Ramsay determined the presence of these gases by their spectral conduct. There can be no question of Ramsay's facts, for it is to be assumed that he took the precaution of having the minute quantities of the gases obtained and those in the comparison tubes under similar

[23] *Journal Chemical Society* (London), **91**, 1605 (1907).
[24] *Nature*, **73**, 389 (1906).

pressure, although he does not make that plain. Keeler[25] has called attention to the five spectra of oxygen which differ so widely in their appearance that there is no indication that they belong to the same substance.

Perhaps the most remarkable portion of this last work of Ramsay, the full account of which, just published, reads like a story of magic, had to do with the solutions of the copper salts in which the emanation performed its devolutions. These solutions after the removal of the copper showed the presence of lithium, the smallest metallic member of the first family in the periodic classification. So careful an experimenter as Ramsay of course took precautions to prove the absence of lithium in any of the apparatus or chemicals used by blank tests.

The facts indicate decomposition, "degradation," as Ramsay put it, and not composition, synthesis. He makes no claim to what has generally been understood by the laity as transmutation, namely, the conversion of silver into gold.

The emanation, in passing through its transformations, evolves much the greater portion of the energy produced by radium and its educts. Metaphysicians, among whom are many of the most matter-of-fact men of science, have long speculated upon the constitution of matter. Time and again it has been urged that the heavy chemical elements would eventually be broken down into lighter ones. All that was needed was sufficient energy, or the right kind of energy, properly applied. Up to the time of Ramsay's work no successfully undisputed experimental facts have been offered in substantiation of these philosophic considerations. Can it be that we have Bacon's "Philosopher's stone" in the form of a storehouse of concentrated energy, the emanation?

It is evident in this limited communication that many omissions have had to be made. I have purposely avoided the complication, which would be introduced by a discussion of the attractive electronic theory of matter. Nor has there been a desire to depict the acrobatic cerebrations of French hylozoists, although Ostwald, perhaps the greatest teacher of chemistry to-day, captains the energistic propaganda.

[25] *Scientific American Supplement*, **88**, 977 (1894).

THE RULE OF THE ROAD

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THE localization through war and barter of the cerebral centers of speech and writing (and hence of intellect) of 98 per cent. of the population in the left half-brain is the cause of right-handedness.[1] The increase of the necessary differentiation of bodily and mental function by the coordination of associated cerebral centers has resulted in a general right-handedness, right-eyedness, etc., the data by vision, audition, and for action of the right leg and foot for associated function, compelling a location of all these centers in the same left-brain and closely linked with the determining faculty of speech and writing. With the two per cent. of left-handed, the reverse of all this takes place. The mystery of the origin of right-handedness is thus cleared up. With this explanation manifest the other concurrent mystery of the rule of the road is of easy solution. Right-handedness, plus the variant circumstances of civilization, the reaction of the right-handed organism to the environment (in the language of evolution), explains all the puzzles of the rule of the road.

Primitive war, as Homer, chivalry, and present-day savage customs demonstrate, regardless of the number of combatants, was a matter of individual encounter, of hand-to-hand conflict. Even when archery, and throwing of spears, javelins, etc., came into use the essential individualism was not changed, and the shielding of the left side, and aggressive use of the right hand continued. All military tactics and drill of numbers was then established as right-handed, down to the most minute particular—and so continues, indeed, although the flung weapon weighs a thousand pounds instead of one or two pounds, and is thrown five miles instead of twenty or fifty feet. After the Trojan war, chariots fell more and more into disuse, and cavalry began to take their place, but this in no way changed the evolution of right-handed tactics. In Alexander's time the right flank of the phalanx was the post of honor, called the head, the left the tail, and marches and movements were made by the right. The commander had his station on the right. So strongly established was right-handedness as early as the half-legendary Amazonian times, that the Amazon had her right breast excised in order that she might hurl the javelin and shoot the arrow with greater freedom and accuracy.

[1] See POPULAR SCIENCE MONTHLY, August, 1904.

Thus not only right-handedness in the vast majority of people, but with it right-eyedness, etc., firmly fixed and differentiated, comes down to the beginnings of civilization. But this is far from implying that in meeting, either two or thousands of people invariably passed each other to the right. This is proved by the classical instance given by Dante in the eighteenth Canto of the Inferno in these words—translation of Longfellow:

> Even as the Romans, for the mighty host,
> The year of Jubilee, upon the bridge,
> Have chosen a mode to pass the people over;
> For all upon one side upon the Castle
> Their faces have, and go unto St. Peter's;
> On the other side they go unto the mountain.

Not only was the Papal order necessary to make the crowd keep to the right in coming and going, but a barrier was erected along the middle of the bridge so that the crowd could not interfere with one another. Further particulars are given in Longfellow's note to the passage, and by other commentators of Dante. In our own times the custom of foot-passengers is more firmly established, "As was well illustrated recently in the Paris Exhibition in the case of the two large wooden bridges erected opposite the Trocadero to convey foot-passengers over the roadway. Here, although for what reason was not apparent, the authorities commanded the people to pass over the bridges to the left, instead of, as in the case of other bridges in the same exhibition, to the right. After crossing the bridges the majority of the crowd would be seen bearing to the right, causing endless pushing in crowded days." But that many, especially women and children, are to-day reckless of the rule, is illustrated in the crowded side-walks of American cities.

Whenever, and that was generally, the custom and rule of orderly government was established by military usage, the ancient and persistent habit of passing to the right arose naturally from the necessity of keeping the enemy on the left side. This was the shielded side and gave combatants greater safety, as well as insured greater freedom and efficiency for the aggressive right arm and hand.

The crux of the difficulty in explaining divergent usage is encountered by the strange seeming anomaly of English practise. Wherever English usage obtains, the carriages and horsemen pass to the left, although foot-passengers pass to the right. That the foot-passengers keep to the right is natural, because it was derived from ages of military precedent. But another and overlooked fact doubtless contributed to prevent the English walkers from adopting the wagoner's rule of passing to the left. This was the growth of town and of city life. All urban life was conditioned by narrow streets, so narrow

that our modern city alleys are in comparison wide.[2] At first, indeed, there were no sidewalks, and there was room at the sides, when a cart or carriage occupied the center, for only one person to walk between the wagon and the houses. Hence plazas, open spaces and squares, were the meeting places of the citizens. Quarrels and fighting were always taking place in the "streets," garbage and refuse (*gare à l'eau!*) were thrown from the windows into the center of the streets—which thus became open sewers, and the mud, etc., of passing vehicles had to be avoided with great dexterity by the foot-passers. And literally with great "dexterity." The left or shielded side, although shields might not be used, would naturally be that presented to the center of the street. The right side was thus chosen to keep the right hand or armed side of the body free for action, to avoid the mud, to escape the refuse flung from above, etc. And if one protected a lady, she was, as to-day, given the side next the house-walls. When wider streets and sidewalks came into existence the right-passing custom was already established; and the still-remaining narrow ones in old cities insured its maintenance.

But why did the English early adopt the habit of passing their vehicles to the left? The contradictory rules have tormented visitors, evolutionists, the correspondents of *Notes and Queries,* and many periodicals of the last one hundred years, and have been epitomized in many forms, the most common being this:

> The rule of the road is a paradox quite
> In riding or driving along;
> If you keep to the left you are sure to be right;
> If you keep to your right you'll be wrong.
> But in walking, a different custom applies,
> And just the reverse is the rule;
> If you keep to the right, you'll be right, safe, and wise;
> If you keep to the left, you're a fool.

[2] St. Evremond makes his visitor say that in the Paris of his time the streets were muddy whether it rained or not, because everybody threw rubbish of all kinds into the middle of the streets. Ladies had to be carried across the central gutter on the backs of their servants. Men wore top-boots, like those of postilions. Blocks of vehicles constantly occurred, and then there was no respect of persons; ladies whose carriages happened to be entangled in them had to listen to the most frightful oaths and language. There were often duels with whips. Victory did not remain always with the most foul-mouthed. The most dilapidated fiacre would have remained where it was until nightfall sooner than have made way for a court-carriage. Blind people and blind mendicants, criminals and pickpockets thronged everywhere. To the clashing of bells were added the shouts and cries of the perambulating dealers in vegetables, milk, fruit, rags, sand, brooms, fish, and water. The water-carriers numbered some 20,000, each of whom distributed from 30 to 40 pails a day. The tumult of cries kept up night as well as day.

The English rule of the road as to vehicles obtains on the continent only in some Swiss cantons next to Italy, and in Italy. Nowhere, apparently, do foot-passengers, in meeting, ever pass to the left. The method of passing when overtaking another wagon or carriage is also a result of that adopted in meeting. If wagons pass to the right they overtake to the left, and *vice versa*. The rule of all nations at sea, including the English, is uniform—Port your helm!—*i. e.*, pass to the right! This international rule was settled in 1862, yet Harper's "Book of Facts" says that near Great Britain alone there were in the six years ending 1895, some 13,000 collisions at sea.

The English rule of the road was of course socially recognized long in advance of any formal laws or decisions on the subject. So far as I can learn, the first Act of Parliament was enacted in 1835, and reads as follows:

> Any person driving any carriage whatsoever, or riding any horse or other animal, who meeting any other carriage or horse or other animal, shall not keep his carriage or horse or other animal on the left or near side of the road or street, or, if passing any other carriage or horse or other animal going in the same direction shall not in all cases where it is practicable go and pass to the right or off side of such other carriage or horse or other animal, shall be liable to a fine not exceeding 10 shillings.
>
> Any person riding any horse, and leading any other horse, who shall not keep such led horse on the side farthest away from any carriage or person passing him on any public road or in any street of a town shall be liable to a fine not exceeding 10 shillings. (In 14 and 15 Vict. Cap. 92, Sec. XIII.)

The led horse, and especially if the man is himself mounted, requires the man's right hand in leading on the halter of the led horse. Another evident reason why the led horse should be at the right edge of the road is to avoid dangers, both to the led horse and to the approaching person, if the led horse were to pass in the center of the road, and thus graze the passing vehicle, man, or animals.

The universal ancient custom, derived from military drill and right-handed habit, of passing to the right, was therefore unexceptionally continued by all nations except two—England and Italy—and in these two it was continued as to sea-going vessels, as to led horses, and as to foot-passengers. But by these two nations the strange exception is found that vehicles pass to the left. Why?

The suggestion has been made that in England and Italy the diligences, and post-coaches, had to be protected from highwaymen and brigands and this was done by armed postilions; these sat, of course, on the near or left-hand horses, because they were right-handed men (and thus mounted from the left side of the horse), and also because in driving the left hand held the rein while the right hand was kept free to handle the firearms. The theory is that they passed to the left in order the better to fight the highwaymen, who were thus kept on the

right side. This explanation is scarcely explanatory. Were highwaymen not as common in other countries as in Italy and England? Could they not and would they not as footmen attack from the left side of the road as well as from the right? Usage so widespread must have a far more generally acting and ancient habit behind it than this of robbery. All such habits as the rule of the road must have sprung from many and more primitive and humble origins, from the necessities or customs of the common people, in fact, whence as here the few later diligences and post-coaches derived their habits. The conscious legal enactment is merely the late acceptance of centuries of unconscious custom. If suddenly springing into existence, a general change must be the response to a new circumstance of powerful and general application.

Contributing customs or necessities may have cooperated to effect the change in Italy and England from the natural passage of vehicles to the right, making them pass to the left, while foot-passengers, vessels, etc., continued to pass to the right. But it has been overlooked that before vehicles had come into use horseback-riding must have set the fashion in passing because the riding of horses, asses, mules, etc., must have long preceded the existence of the wheeled vehicle of any kind. For perhaps a thousand years (as now in a large part of the earth's surface) it must have been impossible for transportation of goods or men to be effected by wagons, and only by horses, pack-mules, etc. During this time the rule of the road must have been fixed pretty rigidly, especially as the narrow "trail" or path would not everywhere allow meeting riders to pass, but only in certain wider or more open spaces. In all civilized countries, except the two mentioned, the fact that subsequent customs demand the passage to the right shows that, during the preceding centuries, the ridden horses and pack-animals must have passed to the right. One can scarcely doubt that the ridden horses of England and Italy did the same. This seems only to deepen the mystery of their contrary practise to-day.

The mystery, I suspect, is resolved by the forgotten fact of the tremendous, fashion-setting, and centuries-long influence of chivalry with its tourneys, joustings, and knightly battles on horseback, with ax, sword, spear, tilting lance or pole. Those who have studied and realize the vast domination of chivalry can easily comprehend the rôle it played as its vogue after centuries melted into plebeian tilling the soil, commercialism, and roads covered with wagons, coaches, etc. The horseback fights and mock-battles of the troubadours, minnie signers, knights, and aristocrats of these centuries were possible only by the contestants meeting and passing to the left. It is needless to illustrate the fact from histories of chivalry, from medieval legends, tales, adventures, etc., whether of the Arthurian cycle, or Ariosto, or a hundred

aftercomers. The club, spear, sword or pole must be held in the right hand and the reins in the left; the horses and riders passed necessarily to the left. There could have been no game or reality of battle if the passing were to the right. The holding the spear, lance, ax or pole was dictated by right-handedness, and to fight each other they had to pass to the left. Thus right-handedness begot left-passing, owing to the peculiar conditions of the battling or jousting.

The conclusion draws itself: this must have settled the fashion of horses (and riders) passing to the left wherever chivalry was merged into wagoning by an evolutionary process. I judge it was thus transformed in Italy and England, and that on the continent the wagon and post-chaise were not slowly derived from the fashion of chivalry. We have a capital proof of the fact, as regards England, where antiquarian research demonstrates that the postilion phase of development was not long-continued or generally practised. For the postilion period (dominative and even tyrannical in France, as her literature shows) must evolutionally be considered as the intermediate between horseback-riding, and driving from the wagon-seat or box. In England the driver, as it were, jumped directly upon the wagon-seat from the ground, or on the back of the horse without a vehicle, while on the continent, for hundreds of years, the horse of the rider hauled a vehicle behind him, and the representative of the former knight and rider became a postilion. Lack of information compels me to confess that the actual and detailed steps of the evolution in Italy are not clear to me. But in England the postilion's office was short or non-existent, and in early times the drivers of wagons, carts, etc., walked, of course, on the left or near side of the horse or team. Probably the walking was because a single horse, instead of two or four, was the rule, as the costermonger's cart and the Irish car to-day illustrate. On the continent the teams were of two, or four, or more horses, and the postilion rode one of the "near" horses; this may be seen in pictures of Paul Lacroix, "The Eighteenth Century," especially that of the "Carabas," on page 448. By the seventeenth century, as is shown on pages 6, 44, etc., the driver had mounted on the box, but the postilion was continued on the wheel-horse or, in case of three or four pairs of horses, on the near leader of the team. There can be no doubt that those who have explained the rule of the road for vehicles, as due to the position of the driver or postilion on the box or seat, took *post hoc* for *propter hoc*; the custom had already been long established before either variant arose. The extreme of the *post hoc* argument is seen in the frequently adduced statement that to have the whip-hand free, the driver sits on the right side of the seat, and *hence* passes to the left in order that he may better see that the wheels of the two vehicles do not collide. A similar illusory explanation credits the English left-

passing to the fact that the early drivers *walked* on the left of the horses, and consequently they passed to the left to avoid being ground between the two sets of wheels. King Arthur and Tristram and their fellows had settled that, one judges, a thousand years previously.

Why did the American colonists from England reverse the rule of the mother country as to vehicles passing to the left? That is the remaining riddle which has perplexed every writer upon the subject. There seems to be no exception, the Virginia colonists, who were so largely horseback-riders, developed the rule of passing to the right as spontaneously as the New Englanders. In Canada there appears to have been a noteworthy indecision in earlier days; in some places, as Toronto and St. John, New Brunswick, the English custom prevailed. My reports are that to-day the American custom, if we may so name it (passing to the right) is being increasingly adopted.

The change of the colonists to the American practise has been credited to the necessity of keeping to the right in snow-drifted roadways—surely an invalid argument from evident reasons. The use of ox-teams is also said to have brought the change about. This was perhaps a minor contributory cause, but, like the preceding, will not explain the spontaneity and universality of the American habit. Another explanation that has been offered for our passing to the right is that in early days of narrow and depressed roads the driver could the better judge of the danger from the bank or "lift" of the roadway on the right. Lastly, it has been suggested that lurking savages in the woods at the sides (both sides) of the road made the change of practise. But just how either cause compelled the colonial wagoners to pass to the right, or how they bettered their condition by doing so, one vainly tries to discover.

The real explanation of the change comes to light in a more careful observation and history of the actual facts and conditions of the colonial immigrants. In the first place, they were not in the beginning even preponderatingly English. We appear prone to forget that the first Puritan settlers were mostly Dutch, to which France quickly added her complement, both of continental or right-passing people. Then it must be remembered that the long first period of settlement was not only wagonless, but even horseless, and even English folk when afoot had never ceased to be right-passers. The ox-team, the ridden horse and the led horse were the first means of transportation, and all these methods would insure the beginnings of the customs of right-passing and soon establish it as the rule. It must have been a long and fashion-fixing period before the wheeled vehicle could have come into any general use to meddle with the already established custom of right passing. Most powerful too must have been the dominating

factor of the long interregnum-disuse of the English custom, whereby men's minds were freed from the influence of the special force which had made the old English custom differ from that of the continent. In the old countries war and jealousy, quarrels and crime, made men watchful of each other, kept old customs in vigor, etc., while with our colonists the common enemy banded our ancestors together in friendship and mutual trust. The habits of the continental immigrant also came into action, so that with the factors of disuse, of walkers, of horse-riders, of ox-teams, etc., all uniting, the more natural and universal law came to be customary. Two other necessities cooperated to win the easy establishment of the change: When wagons came into use they were hauled by two, by three, often by four or even by six horses or mules. The driver, of course, being a right-handed man, sat upon the near wheel-horse, and guided the leaders by the "jerk-line," held again, of course, in the left hand. The "prairie schooner" was an illustration of this universal American custom, and the six-mule team of all our armies in the war of the sixties was and remains a distinctive proof of conditions which gave it birth during the earlier history of the country. When the driver left his near wheel-horse and jerk-line, and mounted the seat in the "schooner," wagon, carriage, etc., handling the pair of reins for each pair of horses, there was the best reason in the world, wholly overlooked by writers, that he should sit on the *right* of the seat as did and does the driver in England, although he did not, as do they, pass to the left. This reason is that he might operate the brake with his right hand or right foot. In a hilly country and with ungraded roads, the braking was fully as necessary as the driving. The combined force of all these factors is fully sufficient to account for the change in our country's custom from that of England.

But the most interesting and by all odds the most financially important part of the story still remains—that concerning the railways. The history of double-tracking in the United States is not yet written. An illustration of what took place on one trunk line, the Union Pacific, is not very different from that on others. This company in constructing its line across Idaho put in sidings one and one half miles long, every three miles, and located these all upon the same side of the track, the object being to utilize these as parts of a second continuous track at a later day. The English rule was of course to pass to the left, as with carriages in the common highways and streets, a rule naturally adopted in Europe, India, etc. In our country there was said to have been sufficiently active political feeling to think that "what was English was bad," and from the first this made some of the double-track railways right-hand passers. I very much doubt this; the right passing of our common wagons even in revolutionary times had

become the invariable rule, and so, despite the influence of England, her engineers, etc., the right-hand rule in our own railway orders, was in the last century usually adopted. We still have three double-track railways which, owing to English habit, having started as left-passers, still continue the practise—the Lake Shore, the Chicago and Northwestern, and the Great Northern. All others have been right-hand roads from the beginning of double tracking. It is most astonishing to find that any railway in double-tracking should have adopted left-passing, because the engineer sits (or stands) always on the right side of his engine or cab, and uses his left hand on the throttle, observing the signals at his right. In left-hand roads it is plain that he is at a disadvantage in seeing the signals because of intervening trains or cars upon the track at his right. A great element of danger is thus introduced. This may possibly help to account for the existence of two exceptions to the rule in England—one between Charing Cross and Cannon Street in London, and another, one of the first suburban lines run out of London, that formerly known as the Greenwich Railway, from London Bridge to Greenwich. Various explanations have been suggested to explain these exceptions to the rule.

The danger in left-hand roads of obscured signals by intervening trains must at least complicate and make more expensive the working, and it will never be learned how many accidents and wrecks may have been caused by the unnatural method. Even on right-hand roads the signal systems alone are now costing more than the entire construction a little while ago. Some 50 miles of modern signal systems are being put in by the New York Central Railway at a cost of $60,000 a mile, or $3,000,000 in all. There are all-controlling reasons why, once established, a modern left-hand railway can not change to a right-hand one, although the disadvantages of left-hand roads grow amazingly every year. The switches into factories, mills, yards, etc., once established must be kept up, and hundreds of millions of dollars' worth of property and vested rights are concerned. A train should enter a switch "head-on," and established switches are so designed.

Incidentally the history of signals is of interest. At first watchmen or policemen were stationed along the line as signalmen using white and red flags in the daytime, and at night lanterns of the same colors. The signalmen at first stood upon the track, then to one side. The mechanical signals are at present often overhead. When the man was displaced by a mechanical device it was at first the figure of a man, with body, head, etc., and with two arms rising and falling as did the living man's arms. Then, the signal was vertically cut in two leaving the man's half-body, half-head and one arm. That one arm is now in lineal descent represented by the dropping and rising arm

of the semaphore signal. A writer in *Pall Mall,* 1902, thus describes the extension of the signal system:

> However, as traffic increased, fixed signals, first of the disc and then of the now universal semaphore pattern, were introduced, and worked by hand—that is, by means of a handle at the foot of the post. The idea of manipulating a cluster of these signals, together with track switches, was suggested by the inventive genius of a lazy Irish porter. The latter had two signals, some distance apart, to attend to; and in order to save himself the walk, he counterweighted the handle of one, and tied to it a length of clothes-line. Thus while standing at the one he was able to operate the other. An inspector chanced to see the rude though efficient mechanical device, and ordered some experiments on the same principle to be carried out in Camden goods yard—for the incident occurred on the North Western Line—with the result that the system of actuating signals from cabins or boxes by means of levers and wires was introduced. The first arrangement of concentrated levers equipped with an interlocking apparatus was invented in 1843.

The entire question of working a double-track road and its signals, and especially of a left-hand road, depends upon general right-handedness, etc., particularly upon right-eyedness, and more than all else upon the fact that the driver or locomotive engineer sits or stands upon the right-hand side of his boiler or cab. The factor that has been utterly overlooked, by writers, by railway managers, by everybody connected with or interested in the problem, is that the engineer stands or sits where he does simply and solely because he is a right-eyed man. It is all as easily demonstrated as the existence of right-eyedness by the experiment with a pencil: Hold up a card or blotting sheet so that the left eye is covered by it and the right views the scene or landscape; then suddenly move the card so that the right eye is covered by it and the left eye is the used one. At once the whole scene "jumps," intermediate objects are in an entirely different relation to those more distant, there is doubt and uncertainty of localization, there is discomfort, and a clear desire and attempt to get the right eye into use. Look at moving objects and the troubles are increased; ride in the engineer's cab and they are doubled again; when sitting on the left side and looking out of the left-side window, it is necessary to put the whole head, that is, the right-eye, out, in order to be sure about the approaching objects, signals and their relations. Sit on the right side and at once it is recognized that it is only the right eye that need be put outside the window in order to see correctly and to satisfy the mind. It is most curious and of absorbing interest to see how this fact was slowly, unconsciously, blindly recognized, but without ever being uttered or brought to consciousness in the history of locomotive-engine building and early railroading. If you ask any railway official or chief engineer of a modern railway why the engineer sits on the right-hand side of his cab, disusing his skilled and strong right hand

and using the left on the lever of the throttle valve, that lever on which all force and safety depends, and you will be answered by a blank stare of wonder at such a question, or there will be something said about the wagon-driver sitting on the right of the seat, about the use of the strong right hand ready for the application of brakes, for whistling, for the reversing lever, for bell-ringing, etc. All of which is most wide of the mark.

In the beginning of engine building, there was no "cab" and even in England to-day there is none; and also no seat for the engineer to sit upon. He simply looks out in the face of the wind and storm along the right hand side of his boiler, at the track in front of him. The very earliest machines, *The Newton,* 1680; *The Cugnot,* 1769; *The Murdoch,* 1784; *The Symington,* 1786; were directed by the engineer or driver in front of the boiler, and by both hands. But as early as 1790, with *The Read,* the engineer had learned that he must stand behind his boiler, although the older method of operating from the front of the boiler reappeared as late as 1803, *The Trevicks,* in 1821; *The Griffith,* and even in 1824, *The James,* etc. In some cases, as in *The Killingworth,* 1825, the location of the engineer is doubtful. It is interesting and instructive to watch the struggle from 1790 onward between the conflicting unconscious tendencies and demands of the right-handed and right-eyed engineers (an occasional left-eyed engineer may have obscured and lengthened the progress) and the engine-makers who were still more oblivious of right-eyedness. In *The Read,* of 1790, both hands were used on the throttle and there is no intimation as to right-eyedness or the side of the engine whence the outlook was made. In 1801 in the *First Trevicks* engine, and in 1803 the *Second Trevicks,* the throttle lever was held in the right hand, and the engineer looked along the left side of the boiler. In the 1808 *Trevicks* this was also the rule. In the 1805 *Trevicks* both hands seem to have been used, and so if, as appears from the picture, the right eye looking past the right side of the boiler was the custom. The dominant influence of the right hand is steadily shown in *The Blankincop,* 1812; *Stevens' America,* 1829; *Puffing Billy,* 1813; *Blucher,* 1814; *Locomotice,* 1825; *Seguin,* 1827; *Royal George,* 1827; *Stephenson's Twin Sisters,* 1827; *Hackworch's Globe,* 1830; *Bury,* 1830. In all these, probably or surely, the driver stood upon the left side of the boiler and watched the track in front from his side. He naturally wanted to use the right hand as the throttle-hand, and had not yet discovered the ocular problem. From 1829, with *The Rocket, The Costello,* 1831; *The Lafayette,* 1837; *The Hector,* 1839; *Hinkley's Lion; Gooch's Great Western,* and all subsequent machines, the necessity of looking with the right eye along the right hand side of the boiler at the track and signals, became dominant, and dictated the placing and direction of the throttle-valve

handle. With the late construction of the "cab" of the driver, the needs of the right eye were accentuated because the engineer in looking out of the window at his right hand is compelled to put no more than his right eye out of the cab-window. If he put the left eye out of the left-side window he would have to put the entire head out in order to see with the right eye. Thus right-eyedness has unconsciously compelled the driver to disuse the right hand for the naturally expert work with the throttle-valve, in order that the greater danger may be avoided that would follow both to the engineer and to his train, from putting the whole head out of the left window of the cab.

Among the many ocular problems of railway employees those relating to deficient color-perception are of great importance, but equally great are those regarding presbyopia or the failure of visual acuteness after 40 or 45 years of age, and especially should the diagnosis of right-eyedness or left-eyedness be held of prime necessity. The left hand may be allowed, somewhat against nature, to manage the throttle-lever, but the right eye must be the absolute judge of signals, etc. Undoubtedly there are a few hundred, at least, of left-eyed engineers, signalmen, etc., on our roads, and their disability for their peculiar calling is greatly endangering lives and property. Nor should it be forgotten that there are generally proportionally more left-eyed than left-handed men. As trolley-car "gripmen" or engineers, chauffeurs of automobiles, etc., the left-eyed are at only a slight disadvantage, because nothing is in front of their eyes to impede the dominant function of the right eye. Despite this fact the automobile chauffeur sits on the right-hand seat, not only because of inherited custom, but again that his right eye may have the slight advantage of position and that his right hand may be free to use in almost every instant's emergency. In our trolley cars and electric locomotives the all-important brake is operated with the right hand.

To epitomize, the resolution of the mysteries as to the origin of right-handedness and the rule of the road may be made only by grasping the phenomena as a whole, *i. e.*, by massing the facts of the entire history from prehistoric savage battle and barter to the expert locomotive-engineer of to-day running a "limited" train at the rate of a mile or more a minute on a two-track or four-track railway. Even the cave men show that right-handedness was the rule in their time, and spear-hand, shield-hand, gesture-language, digital-counting, and the tally-stick, the world over, fixed the speech and writing and right-hand brain-centers in the left half-brain—and, of course, those of the left-hand and fingers in the right half-brain. War made up the life and set all the fashions of beginning civilization, and war together with narrow streets established the custom of right-hand passing, for walkers, riders of horses, asses, mules, etc., and for drivers of all

vehicles, and for vessels. For walkers and vessels no people ever changed the custom, but especially the English, while preserving right-hand passing in foot-passengers and on the sea, anomalously developed left-hand passing for vehicles, and the same, of course, for double-track railroads. What everybody has failed to see is that right-handedness is necessarily bound up with right-footedness, and right-eyedness, because all closely united functions of the body must be correlated and their centers of motion located in contiguity and upon one side of the brain, in order to make effectual and rapid all responses of the organism to circumstance or environment. This works toward a necessary and desirable differentiation of function that makes the aims of the "ambidexterity" sillies more than resultless and foolish. Because whenever a center or congress of centers is developed in one half-brain, disuse and transfer to the other half is, according to age, either impossible, faulty, handicapping, or disease-producing. Coordinated functions of the body require coordinated and contiguous nerve-centers upon the same side of the brain, at least so far as is possible. If one or two dextral factors are in opposite cerebral hemispheres, responsive and quickly-acting coordinated functions will be slower and more inaccurate than if on a single side. The English left-hand passing of vehicles is probably due to the influence of the single-hand fights on foot, tourneyings and joustings of horseback riders, in which meeting and passing to the left was inevitable. The custom grew and continued directly into that of the wagon-drivers. In the United States there was a reversion to the right-hand passing of vehicles, because of the abeyance of left-hand passing of vehicles, and of vehicles themselves, for so long, with growth of the natural right-hand passing by walkers, horseback-riders, ox-teams, and wagons with drivers on the near-wheel horse, such as is found in the later prairie-schooner, and six-mule army-wagon. Three double-track railways in the United States still pass their trains to the left, an absurd and bad custom, expensive and productive of wrecks. But despite this the enginer sits upon the right of his cab, because he can in this place better observe the track and signals in front and to his right, and with the dominant right eye only outside of the cab-window, whereas, if sitting on the left, he would be compelled to put the entire head out in order to see with the right eye, and, even then, because of the boiler, not so well. Only right-eyedness will explain the long, doubtful, and varying custom in engine-building as to the position of the engineer in the beginning of history of railway construction and signaling.

GOLD

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MUCH of the romance and glamor that in former times attached itself to the mental concept and the actuality of gold has passed away, partially because the yellow metal is becoming so common among civilized people, but mainly because in the hurry of modern life we have so many other things to think of. We take it much as a matter of course, just as we do our electric lights, telephones, wireless telegrams and other modern marvels. Yet there is a potentiality and uniqueness in gold that is possessed by no other natural or artificial product in the world, not even diamonds; namely, its apparently unchangeable value.

So far as words and terms go, an ounce of fine gold has been worth among civilized people, and at any time during the last one hundred years, just $20.67, or its equivalent in English, German or French money, and no less, though at times a little more. No other substance that the reader can mention has acquired this characteristic. Violent fluctuations have occurred in the price of every commodity or product. Wheat has ranged from $1.00 to $3.00 per quarter, wool from 4 cents to 20 cents per pound, copper from $200 to $600 per ton, etc. Even diamonds have ranged from $10 to $50 per carat.

But through all these changes gold has been steadily at one price. At least one could always get the equivalent of $20.67 per ounce for it in coin. Why? Because, by legislative action, all the great nations have agreed to accept it from any source and in unlimited quantity, at their mints, and to transform it into coins of definite weight and purity, at a mere nominal charge to cover the expenses of the operation.

This is what is meant by the free and unlimited coinage of gold. Each civilized nation works up the metal into coins in a way of its own, but all upon the same fundamental principles, and from the same starting point. The result is that the gold coins of the world have a definite and unvarying value in terms of themselves. Thus, the English sovereign always contains just so many grains of chemically pure gold, and so also does the French louis the American eagle, and the German 20-mark piece, the balance being a base metal (usually copper) that is added because gold is a soft metal and would quickly suffer loss in weight if put into circulation in a pure state.

Even the resulting alloy is not so hard as the mints would like it

to be, for if you put a score of gold coins in a buckskin bag, and shake them up vigorously for a few hours, you will find that each has lost slightly in weight in the operation; and in the bag, in the shape of fine particles, will be the gold that has been rubbed from each coin by contact with its neighbor.

This is what is called "coin sweating," and if you try it to prove whether my statement is correct or not, do so by yourself and keep the matter dark, for it is against the laws of all countries, and punishable by as severe penalties as those meted out to the counterfeiter. For in appearance the coin will not be altered by a moderate amount of such treatment, and if a man should steadily employ himself in the operation, and could be continually getting a stock of fresh coins to operate on, he might be able to accumulate as much as fifty cents' worth of gold dust per day as the result of his labors.

But it will not do to confuse in one's mind the metal gold with the coin gold. For while the former under the existing laws has an absolutely unchangeable value, expressed in terms of money, the gold coins of different nations vary continually in value as expressed in terms of each other. Thus, the English sovereign fluctuates from $4.82 to $4.89 in American money, and the other European gold coins all vary likewise. This is due, of course, to the exigencies of international exchange, and to the fact that each coin is legal tender for the payment of a debt only in the nationality whose mint has issued it. Thus, when an English wheat or cotton merchant has bought a shipload of either of these commodities from an American producer he can not pay for it in English coin, but must buy American coin to discharge his debt. This he arranges through his bank, and if the demand for American coin for the payment of such debts by Europeans is active the price for the American dollar, as expressed in terms of foreign coin, advances little by little until it reaches a point where the English merchant (or his banker) will find it just as cheap to ship sovereigns (or even uncoined bullion) over to America, take it to the mint, have it melted and manufactured into American coins, and with these discharge the obligation. When such a condition of affairs occurs the gold-exporting point is said to have been attained in London, and the gold-importing point in New York, and because of it you can never tell whether the gold you hold in your hand, though bearing the Goddess of Liberty on its face, has come from the mines of America or from those of South Africa or China. But it makes no difference, for the inherent physical qualities of the metal are the same, no matter at what place in the earth's crust it originated.

However, we are considering gold the metal, and not gold the coin, and in again reverting to the subject it is necessary to call attention to another very marked characteristic of the metal, which it shares

with but few other substances that man produces. If you are a farmer, and produce wheat, cotton, tobacco or any other of the ordinary farm products, you know very well by experience that when the harvest season comes around again the crop that you sold last year will practically have disappeared, and there will be room in the markets for the new one you have for sale. Your wheat will have been eaten up, your cotton woven into clothing and your tobacco disposed of in the form of smoke. If you are a producer of food animals, or a fisherman, the same will have happened. If you are a lumberman your boards will have been put into buildings or furniture, which in due time must be renewed. If you are a coal miner your crop is transformed by the consumer into gas and smoke about as fast as you dig it from the earth. If you are an iron, copper, lead or zinc miner your commodity begins to deteriorate in value the instant it goes into usage, and in five, ten, twenty or fifty years at the utmost the articles into which the bulk of these metals are worked up will have rusted or worn out and must be replaced.

But not so with gold. The coin you hold in your hand to-day may, for all you know, have been part of the gilding of the dome of King Solomon's temple, in Jerusalem. The case of the watch in your pocket was perhaps taken from the mines of Spain by the early Romans, a thousand years before our era. The ring you give your betrothed may be wrought from a lump of metal washed by the prehistoric miner from the stream beds of Rhodesia or India.

Who can tell? For gold can not be eaten or burned up. It can only be lost, and the whole world is interested in preventing that fate, and in taking the greatest of precautions against its diminution by wear. Hence gold is what may be called a cumulative crop. The quantity in the hands of man would continually increase, if the crop were a regular one and loss could be prevented. To a certain extent the same is true of silver, but there are no other manufactured substances, except these two metals and the gem stones, that do not steadily and even rapidly deteriorate or disappear. Even gold is somewhat subject to the law of decay, for that part of the annual crop that is used in dentistry, in photography and in gilding is rarely employed again for any other purpose, and in a generation or two has gone back to earth.

How then about the annual crop of gold? Whence does it come, what does it amount to, and how long can we go on extracting it from the bowels of the earth without disturbing the qualities that it seems to have in the commercial and industrial world? These are interesting questions that can only be answered by looking backward into the history of the metal, as well as considering its position at the present day.

It is fairly well settled that the gold of the ancients came mainly from three places, namely, Asia Minor, southern India and South Africa. In the first-mentioned locality it was principally obtained by washing the banks and bars, and even the beds of certain streams, while in the last two it seems to have come more largely from crushing the outcrops of auriferous quartz veins. What is known as the Dekkan region of the peninsula of Hindustan, and certain parts of the valleys of the Limpopo and Zambesi, in South Africa, are dotted with the remains of prehistoric excavations on such veins, some of which when cleaned out show that the workers succeeded in penetrating in places as much as two hundred feet into the earth; while in the same neighborhoods we find the relics of human structures whose age is certainly only to be reckoned in terms of thousands of years. In India, after many years of tribulation, a modern gold-mining industry has been successfully reestablished on the basis of the old one, and in South Africa the region now known as Rhodesia, where the ancients conducted very extensive operations, is slowly undergoing the processes of rehabitation.

Many of the rivers of Asia Minor were noted three to five thousand years ago for the gold washed from their beds. Crœsus, one of the kings of Lydia, who became extremely wealthy through the working with slaves of some of the stream beds of his kingdom, was one of the celebrated actual characters of that country and those times, and the river of Pactolus, whose golden sands are mentioned by several ancient historians, was one of the most noted of its metal-bearing streams.

It is probable that in the prehistoric and early historic periods of civilization gold in some quantities (not large) came also from the headwaters of the White Nile in Abyssinia, from southern Persia, from some of the East Indian isles and from China. There is no evidence that the Ural deposits in Russia were known in those remote days, but it seems very likely that a fair amount of the precious metal was obtained from the flanks of the Atlas range of mountains in northern Africa.

When I mention the ancients I mean that period of the world's history (and all the unknown eras before it) that culminated in Phœnician nationality, covering the Egyptian, Babylonian, Assyrian, Hittite and Persian empires, and the vast but quiet civilization in Hindustan, China and Japan. In the main the people of those days were Asiatics and Africans, and belonged to the Semitic and Turanian races, though the Persians and Hindoos were more or less Aryan in race and language and northern in temperament.

About 1000 B.C., when Greek nationality began to assume a commanding position, and when most of the older southern empires had passed their prime, when, in fact, the day of Europe was beginning

and that of Asia and Africa was declining, there was, according to history, a very marked decrease in the supply of gold coming into the channels of civilization. The southern African and Indian fields seem to have been deserted, probably because the nation that appears to have conducted operations in these localities (the Phœnician) lost its predominance. Gold gradually became scarce, and its place in business life was largely taken by silver, which came in enormous quantities to the Grecian and Roman world of the period of 1000 B.C. to 500 B.C., first from the mines of Greece, and later from those of Italy and Spain.

The placer-mining regions of Asia Minor had either become exhausted, or, what is much more likely, the industry was ruined by the continual wars that occurred in the days when Asia and Europe were contending with each other for supremacy in that rich and rugged land.

During the early centuries of our own era, when Rome was in its prime, we hear very little of gold mining, and it is extremely likely that the greater part of the yellow metal that was accumulated by the Romans came from the spoliation of older civilizations. When Rome ceased to be a dominating factor in the history of the world, and its vast empire was split into numerous small states, mining as an industry, and particularly gold mining, suffered greatly, and the Grecian and Italian and Spanish silver mines ceased production almost entirely.

It was this fact that ultimately caused the establishment of the institution of banks in northern Italy, the then commercial center of the world, and it is a curious fact that these banks were not places where coined money was deposited or dealt in, but where credits were established and maintained. Thus the great bank of Venice, which for 600 years (800 A.D. to 1400 A.D.) was really the heart of the commercial world of the day, was little more than a great bookkeeping establishment, where the trade between Europe and Asia was kept in balance by a system of transfer of credits, these credits being based upon the actual possession by the principal traders of the time of the merchandise in which they dealt.

Gold coin in the middle ages almost disappeared from circulation, and silver coins were debased by the governments with lead and zinc and tin until they were current only at enormous discount. In the middle of this period the precious-metal mines of central Europe were discovered, but they yielded mainly silver, and not much of that, so that in the fifteenth century, just before the discovery of the New World by Columbus, commercial Europe was really in great need of coin metal.

In 1492 the western continent was discovered, and in 1498 the Portuguese navigator, Vasco da Gama, first made the passage to the East Indies by way of the Cape of Good Hope, and almost simulta-

neously other navigators of the same nationality landed on the eastern coast of South America and took possession of the country for the throne of Portugal, under the name of Brazil.

History tells what a marvelous change came over Europe as the spoils from the East Indies, consisting mainly of gold and precious stones, and the silver and gold from Mexico and Peru, began to flow into the channels of trade. This was intensified when the Brazilian gold fields (placers) were opened in 1675, and under the impetus of this fresh and enormous volume of new circulating medium the modern era began.

But as yet there was no such thing as an established precious-metal mining industry. The millions that had come from Spanish America and the East in the years between 1510 and 1700 were largely spoils, or the result of crude operations on alluvial deposits, and when the flood began to slacken Europe fell on hard times again, like a young rake that had lived beyond his income. This brought on the era of dissatisfaction that caused the beginning of emigration among the French, English and Dutch to North America, resulting in the partition of the continent among these races, and the formation of the American republic and the colony of Canada, where up to the middle of the nineteenth century (less than seventy years ago) gold coin was almost unknown, and the real medium of exchange was mainly the Mexican silver dollar.

In 1849 the gold fields of California and Australia were almost simultaneously discovered, and during the following ten years more of the precious metal was produced and turned into the channels of trade than had come from the earth for a thousand years previously. But as most of this was derived from alluvial diggings that were quickly exhausted it was really not until 1860 that the modern industry of gold mining began.

Placer or surface mines, where the gold exists in the form of fine grains or dust, are productive and profitable for a time, but are short-lived, while vein or reef mines that extend indefinitely into the earth are permanent, and when these began to be attacked, and machinery was devised to crush the quartz, and quicksilver employed to gather and catch the golden grains, and when finally a smelting industry came into existence, so that the so-called refractory ores could be treated and their precious contents recovered, then and not till then did gold mining become a well-defined business, and the production of the metal fairly constant and regular.

It is a marvelous tale, this history of gold, and wrapped up with it are clues to many obscure points in the story of civilization. For, as the blood to the human system, so has gold been in the commercial world, the circulating medium carrying life to all parts of the social and political organizations that men have constructed.

As already stated, gold mining is of two kinds, or rather the metal occurs in two different ways, each necessitating a particular kind of treatment to recover it. In the one case it is found in the form of a fine dust or grains, and to some extent as large nuggets, in the surface soil or débris, and it is gathered by washing such deposits in troughs called sluices with water. The gold by reason of its weight settles on the floor of the sluice, while the lighter gravel and sand are carried away. These are called placer or alluvial mines, and to this class belong the ancient fields of Asia Minor, the earlier Brazilian producing regions, the areas in California and Australia that yielded so enormously in the years between 1850 and 1860, and the Klondike and Nome deposits of Alaska of the present day.

Geologists tell us that the metal accumulated in these places during countless ages, as the result of erosion caused by rain, frost, heat, cold, glacial action, etc., operating on old granitic and schist rocks, in which occur veins, lodes, reefs and ledges (as they are variously termed) of quartz, which quartz is impregnated with particles of the yellow metal, or with crystals of ores of other metals, such as iron, copper and lead, that contain gold in a state of mechanical or chemical combination. And it is a fact that the deposits of each great alluvial field when followed up have led the explorer to areas of country (usually mountainous) where such quartz veins are found, and it is the exploration and working of these veins that constitute the other kind of gold mining, called quartz mining, which is the permanent form of the industry, and which is now in progress in America, Australia, South Africa, Mexico and India, and is coming slowly but surely into existence in Russia, Brazil, Alaska and Japan.

Alluvial or placer gold mining may be and generally is carried on with a very simple equipment. It is not a business that requires capital. With a pick, shovel, pan, some boards and nails, a hammer and saw and a few pounds of quicksilver, the energetic miner may start in business, and will rarely fail to make expenses and good wages. If he is one of the lucky ones, and gets hold of a rich piece of ground, he is rewarded with a fortune in a very short time.

On the other hand, after an alluvial field has been worked by the individual miner in his rather crude way, and is approaching exhaustion by his methods, it is common for a large number of claims to be consolidated under company or syndicate management and reworked. When this occurs systems of operation are inaugurated by which thousands of cubic yards of ground are washed daily, and modern capital may be advantageously employed in the creation and operation of the installations devised to accomplish the work. These consist of long ditches and pipe lines to bring in the water, lines of sluices in which to do the washing, dredges, elevating devices, undercurrents, etc. There have been built to date over 50,000 miles of ditches in California

alone for use in this branch of business, and more than 200,000 miles in all the gold-producing states of America.

Placer gravel varies in value. The unit of quantity is a cubic yard. In the early days of a new field the ground must carry at least $1 per cubic yard to be attractive to the individual miner or small capitalist. Later, under consolidation and extensive operation, plenty of money can be made out of material carrying fifteen cents per yard, if the physical conditions surrounding the operation are good; that is, plenty of water available and a good dump. At a number of places in the west and in New Zealand good profits are being made from ground carrying much less than fifteen cents per yard.

The business of vein or reef mining is a very much more elaborate and complicated affair. The lodes or veins of gold-bearing quartz that nature has distributed in certain localities in the rocky crust of the earth are from a few hundred to a few thousand feet in length, so far as their outcrop at the surface is concerned, and from a few inches to a dozen feet or more in width. They extend downward no one knows how far, for as yet the deepest explorations made on any one of them have revealed no termination, though at several shafts in America, Australia and South Africa explorations have been pushed to depths of over 3,000 feet.

But the quartz of the vein changes continually in value. Here there may be but a trace of the precious metal, while a few feet or yards away a ton may contain as much as $50 worth. Generally, however, the gold is dispersed throughout the vein in patches called "ore shoots," so that certain areas are clearly payable and others not. This is wholly a relative term, depending upon the width of the quartz, its hardness, the nature and condition of the walls, the presence or absence of water, the price of labor, of explosives and of supplies in general, the cost of power for hoisting, pumping and milling, etc. In Mexico, America and Canada money can generally be made on a vein of a width of five feet, that will yield gold to the extent of $5 per ton, and in a number of instances, where the vein is larger, ore worth much less is yielding handsome dividends. Thus, the Homestake mine in South Dakota is paying magnificently on ore that produces on an average about $3.50 per ton, while the Treadwell mine at Juneau, Alaska, is doing finely on $1.50 rock. On the other hand, in Kalgoorlie, the great Australian gold district, where the veins are comparatively narrow but rich, and all working expenses high by reason of the desert character of the country, the costs connected with mining and milling rarely are less than $7.50 per ton, and in South Africa, where labor has been poor, company management expenses abnormally large, and the payable reef less than twenty inches thick, costs will average even a little more than in Australia.

Now that, at last, after centuries of irregular and haphazard pro-

duction, the business of gold mining is on a stable and permanent foundation, it will be interesting to take account of the current annual crop of gold of the world. That the reader may acquire a mental grasp of its physical proportions it will be well to start with the fact that for the year 1906 this crop weighed nearly 674 tons. A cubic foot of pure gold will weigh just 1,204 pounds, so that the product of the world's gold mines for that year could be all packed in a room ten feet square and nine feet high. This cube was worth in money $407,379,893, and it came from the following places:

South Africa (Transvaal, Rhodesia and West Coast) ...	$133,634,506
America (United States and Alaska)	96,101,400
Australia, Tasmania and New Zealand	82,237,228
Russia and Siberia	22,469,432
Mexico	16,639,350
British America (Canada and New Foundland)	12,116,432
British India	11,925,711
Central and South America	10,970,187
Japan and Korea	7,000,000
Europe (except Russia)	5,616,039
China	4,500,000
All other countries	4,169,608
	$407,379,893
Gain over 1905	$29,411,750

Judging by the experience of the last thirty years, during which the industry has been forming and steadily acquiring those characteristics that indicate stability, it is probable that under normal conditions, and if the laws governing the discovery and exploitation of gold mines in the various countries and those affecting the selling price of the metal (coinage laws) do not materially alter, each year will show a gain of about 5 per cent. in the amount and value of the annual crop.

At the present time, according to calculations and estimates made in 1900 by the director of the United States Mint, the gold that has been taken from the mines of the world since the discovery of America has amounted in quantity to about 21,424 tons, and in value to more than $12,600,000,000.

Now, of this vast total, the astonishing fact is that nineteen per cent., or nearly one fifth of the whole, has been taken out in the last ten years; thirty per cent., or almost one third, in the last twenty years; forty-one per cent. in the last thirty years; fifty-four per cent., or over one half in the last forty years; and sixty-eight per cent., or more than two thirds, in the last half century.

Assuming that no increase at all occurs in the annual output, this amount will be doubled in thirty years, while, if an annual increase of five per cent. is attained, the doubling will be accomplished in less than twenty.

What effect on the commerce and trade of the world will result from the creation in so short a time of so immense an amount of new and indestructible wealth, with a debt-paying quality based wholly on tacit agreement among nations, remains to be seen. That a general advance will occur in the market price of all other commodities may be confidently expected. That interest rates as a whole will decline should be quite as certain. That wages should advance seems also natural, for with that amount of new capital arising in so short a time every department of human activity is bound to be stimulated, and this will create an enormously increased demand not only for all those things that machinery and art can produce, but also for those that can only be brought into being by human hands and human service.

Of course strikes, tumults and wars may for a time cut down even the normal output, as was the case when the South African mines were closed by the Boer war, but this is very unlikely. The financial world has experienced the discomfort that occurs when its gold supply is interfered with, and is not likely to permit another such happening. In other words, the gold-mining industry, like all other international industries, makes for international peace.

An examination of the table of production for 1906 shows that nearly eighty-three per cent. of the total output was made by the Anglo-Saxon world. This is a most significant fact, and the proportion is so overwhelming as to leave no doubt whatever as to the communities that are to stand at the apex of material humanity during the twentieth century. When one looks for the causes that have led up to this astonishing predominance it is necessary candidly to admit at once that it can not be only a question of race, for the gold mines of North America, Australia and South Africa were unknown when Britain sent out her sons to these new lands. It was the lust for gold that sent the Spaniards and the Portuguese abroad, but it is the desire for homes that has spread the English people over the face of the earth. Back of this is the love of freedom, resulting from a national life that has evolved through the centuries a code of human laws fostering individuality and encouraging individual effort. So long as the great men of the race whose dwelling places encircle the globe preserve these ideals, so long will they remain secure and in the lead.

And the commanding position they hold at the present time may be credited entirely to the establishment and growth during the thousand years of English history of the principle (somewhat obscured in certain parts of the English-speaking world) that the land and all that is in it belongs to the people, and that the usage thereof is their direct and inalienable and rightful heritage.

SHALL WE IMPROVE OUR RACE?

BY GUSTAVE MICHAUD, D.Sc.
SAN JOSÉ, COSTA RICA

DURING the last hundred years man has persistently and skilfully practised artificial selection on domestic animals. He has thus sometimes increased tenfold their value to him. Setting aside for reproduction those cows only which gave the greatest amount of milk, and those bulls, the mothers of which participated in the same characteristic, milk-making animals were evolved out of the former indifferent races of cows. The lean, hardy hog of the eighteenth century has been transformed into a wonderful machine for the quick making of fat. Selection practised for speed only has created races of horses which can for a short time compete with a locomotive.

While, in most cases of selection, man had in view the modification of certain physical characteristics, it can not be said that this was always his main purpose. The intellectual selection of animals has also been practised to some extent. Breeders of hunting dogs are as much concerned about what mothers and fathers thought and did in given circumstances as about their shape and color. The results of their work have been races the hunting propensities of which are quite as strong and not altogether unlike the blind impulse which prompts a New York clerk to spend one hundred dollars on hunting implements to get a few birds worth a few cents. The main difference between the hunting dog and the hunting clerk is that the former is mostly a recent product of artificial selection, while the latter is exclusively a result of paleolithic natural selection: at a time when agriculture was unknown, those families whose heads found no pleasure in hunting were slowly but steadily and surely eliminated by hunger and consequent diseases. The others remained.

And the most notable mental transformation undergone by dogs is not the developing of their hunting inclinations nor the creating of their doorkeeping and watching propensities. The dog is to-day the only animal which unmistakably loves his master, which expresses intense joy when shown some kindness or intense grief when told a harsh word. During the the long prehistoric ages, domestic dogs were treated as they are nowadays in savage tribes. Although each family kept a number of them, very little food was ever given them. Hunger killed every year many of them. Those which survived out of every generation were mostly those which had received from their masters some food in time of famine, and they were of course the most affectionate and demonstrative.

It is a popular belief that the domestic cat differs in size only from its cousins, tigers and lions. The fact is that the physical changes brought about in that animal by selection are by far less conspicuous than the mental modification. Cats belong to the most ferocious family of the carnivorous order, and no more effective natural weapon can be found than their short jaw, with its long canines, its formidable muscles and its transversal hinge. It was with this weapon that the prehistoric machairodus killed the mammoth. It is the same weapon which to-day enables the small puma to kill in a few seconds animals of the size of an ox. The first consequence of the domestication of cats has been the elimination by angry parents, generation after generation, of those cats which were most inclined to bite children when teased by them. The result of that selection has been a race which can still use its paws, but which seems almost unable to use on man its best and only deadly weapon, although the restriction is entirely of a mental order.

It must be admitted as a sad truth that, while domestic animals are specialized and brought to a high degree of efficiency, nothing is done for the selection and improvement of man, and this in spite of the fact that modern life calls for an increased specialization in every domain. It can not be said that our statesmen are indifferent to the future of our country, but, while they may know some Latin, Greek, psychology, logic, ethics and metaphysics, they and their generation are, as a rule, woefully ignorant of modern scientific thought and truth. To bring education within the reach of all is, in their opinion, the best way to prepare the coming of a superior race of Americans. They are ignorant or forgetful of the fact that neither acquired knowledge, nor acquired qualities or habits are ever transmitted to offspring. For more than a thousand years the Chinese have been changing the shape of the feet of their girls; for many generations the Flat Head Indians have been altering the shape of the head of their children; for over three thousand years the Jews have practised circumcision; all that work has to be done over again in each generation, none of the children born to these people ever showing any proof of the transmissibility of the characteristics acquired by father or mother or by both. Selection would do for them, in a comparatively short time, what mutilation has never done, will never do. It would do for us what education can not do, yet millions are spent annually for education and not a cent for selection.

Not a cent for intelligent, well-directed selection. Some mental selection is practised by man on man, but it is blind selection. Sometimes it improves the race; sometimes it makes it worse, and nobody seems to care whether it acts one way or the other. The military selection kills or keeps away from marriage ties not only the able-

bodied, but also the intelligent, men, and leaves at home for reproductive purposes the weak-minded. On the other hand, we keep the robbers in prison, but this wise measure was meant for a result which it does not produce, the terrorizing of malefactors, and produces a result for which it was not meant, a decrease in the posterity of offenders. Men of genius and their families have to-day a better chance to survive than they had in the paleolithic age, but how many eminent men spend their whole life in a desperate struggle against poverty and connected diseases, because their genius is not of the kind which brings wealth through the sale of patents!

And if through sheer chance, some great mathematician is evolved one day out of the crowd, the state—who should be ever on the watch for such events and whose main care should be to preserve and increase such sources of light, progress and national glory—does nothing to protect the man of genius against care, disease or anything likely to shorten life nor to multiply the splendid thinking machine which that man is. Ninety-nine times out of a hundred our mathematician marries a woman whose family did not count a single astronomer, physicist or other mathematical mind among its members. The result of such a union is what could be expected. Although genius does not generally die out right away in the first generation, it decreases by half, and further dilutions soon bring it down to nothingness. We know that half a dozen Goethes, Longfellows, Pasteurs, Edisons or Curies will do more to illustrate a period and raise a nation in the eyes of posterity than the most prosperous trade, the most thriving industry or than ten successful wars, yet we rely on chance and on chance alone to get those men. Breeders in their treatment of cattle are more up to date in that respect than the state in its management of men.

Such is our error and some may think that it is beyond correction. In our present state of civilization, compulsion in matter of marriage is out of the question. That is true, but compulsion need not be considered when inducement will succeed. If we bear in mind that lack of money delays or prevents many marriages and that a dowry everywhere increases a girl's chances to be married, we shall have an idea of the way in which the next generation will probably solve the problem. Most young men would consent to take a wife in England rather than in their own city if they were given a life pension for so doing; most men of genius would consent to take a wife from a number of selected young ladies rather than in the crowd if they were forever freed from pecuniary cares and moreover given the assurance that another dowry would be paid at the birth of every one of their children. Why such unions should be less happy than others is not easy to see. The best conjugal harmony is not necessarily found where one of the two

is unable to understand the tastes, leading thoughts and all-absorbing ideal of the other.

The nearest approach to such state interference in intelectual selection can now be observed in the city of Washington. It is of course the unforeseen consequence of laws which were not in the least devised for selective ends; but, in spite of being clumsy, slow and but little discriminating, the process which obliges thousands of men of superior intellect, drawn from all parts of the country, to reside permanently or temporarily with their wives in a city selected for that purpose, could not fail to produce the usual results. The writer has shown elsewhere[1] that in no city or section of the country, nor even of any country, can be found such a high birth rate of genius. Birth rate of genius does not mean here the percentage of men of talent, born everywhere and now living in Washington, but the percentage of those born in Washington, who are now living in all parts of the country.

Our period sees in acquired knowledge a panacea for all evils and we have a federal Bureau of Education. A federal Bureau of Selection may be a distinctive feature of a next and more enlightened period. This institution will take up the work of which the publishers of "Biographical Dictionaries of Contemporary Men and Women of Distinction" now have the undisputed monopoly. Its officers will determine who are our bachelor celebritics and where are the daughters of those who are married. This last datum will be invaluable; if a pure-blood literary woman can not be found for a promising young novelist, a half-breed genius will always be better than a woman of the type of Dickens's wife. The bureau will supervise the education of the nation's future great men; should an Agassiz marry the daughter of a Dana, it will see that Latin and Greek be not allowed to crowd out geology from the educational curriculum of the children born of such a union; fossil studies are not the study of fossils. The organization of meetings and conferences of a literary, scientific and social character, in which men and women of talent will get acquainted with each other will be another duty of the bureau. Some will say that the state can not enter the marriage agency business without losing some of its dignity. If they were transported into the room where naked recruits, huddled together like cattle, are awaiting the medical examination which will decide of their fitness to kill other men in international duels, those same critics would not raise a protest. Such is the power of traditional ideas. There is more shame in the killing than in the marrying business, and it is more honorable for the state to raise the intellectual standard of the nation than to degrade the race, physically, mentally and morally.

[1] *The Century Magazine*, November, 1905.

A TRIP AROUND ICELAND

By L. P. GRATACAP
AMERICAN MUSEUM OF NATURAL HISTORY

IV

THE Almannaja formed the western boundary of this sunken land, and for one mile this extraordinary and unique face of rock extended in a straight line like some artificial creation of masonry. A moatlike trough at its foot held the waters of the Oxara river, which leaped in a high waterfall from its northern extremity.

In the cañon of the Almannaja, from whose eastern edge the road descends to the hotel, every imaginable phase of dislocation and rupture of the surface of igneous rock was seen, and for long distances, beyond the immediate edge of the high palisade, the ground was upheaved and depressed, alternately, by the occurrence of small deep fissures, in whose obscure and hidden recesses the snow lay. These minor rips and tears in the ground were very interesting. Slaggy-looking, ropy, circular mats of the original viscous lava were seen everywhere. The complete demonstration of the viscous pasty flowage was most significant and authentic. The falling masses, blocks and columns choked up the chasms in many places, and made bridges across the rifts. This whole plain is confusedly cracked and opened, the main lines of fission running the length of the valley. The crevices thus formed showed every imaginable state of tumbling—in walls, splits and chaotic rubbish of stones and columns, quite hopelessly attacked by plants and lichens in an effort to straighten out and soften its rugged and gaunt confusion.

Our next stop was to be Geyser, where the hot-water fountains are supposed to play with commendable constancy and where—for truth's sake—we venture to affirm, they don't.

The ride to Geyser was made in two parts. We stopped half-way at a farmhouse, where I saw something of the domestic life of these people, and where—God save the mark—I ate *skyr*. Skyr is a curdled sheep's milk, peculiarly sour and preposterously unpalatable. It is eaten with cow's milk, and is thick, pasty and—intolerable. It would require a Mark Twain to do it justice. With the skyr went a tray full of dreadful bread of two varieties, one a sour black bread, looking like leather flakes, the other whiter and only a little less propitious for the appetite. A third gastronomic enormity was an awful dark brownish-yellow granular cheese in a tin. It smelt like old hay and only Providence knows how it tasted. The saving relic of this feast was crackers

and coffee. Still the hospitality was sincere and appreciated, though for the honor of its recipients it may be stated that it was paid for. The guide and myself bunked in the room where the above banquet was displayed, each on a feather bed with another one on top of that as covering.

After leaving Thingvallir we followed a rude trail over stony ground in the rifted country. The ground rose, until we dominated the broad expanse of the Thingvallir vatn, the superb and enormous expanse of water lying between hills and mountains, with some steeply slanting wedge-formed mountains shooting out of its placid waters, as if partially submerged by the eastward tipping of its basin. The view backward in the clear air, in which no trace of contamination lingered, was indeed beautiful, and the little red-roofed church as a spot of color in the scene brought with it the needed suggestion of some sort of human occupancy.

We stumbled along up natural steps of rock, near the edge of the lake, sharply rising, and later crossed the dry and contorted lineaments of the Hrafnagja (raven's wing); another rift, companion to the mighty Almannaja, less august, and more rudely formed. We were now in the "lava beds," a tangled barren region strewn with fragments of rock and thinly invaded by soil and flowers. It seemed almost as if we were on the back of the land, and looking off to its dispersed members below us. The rocks about us were vesicular, slaggy and scoriaceous. Some blistered pieces might have come from a shaft furnace. This region was most desolate, marked also by low shafts or irregular prominences of rock, while with festive hopefulness cow-berry and plantain, grass of Parnassus, ground pinks and other flowers decorated the niches or clung charmingly to the ledges and interstices of the rocks.

All the while the superb pictures north and south changed and developed. We were now approaching a most congruously strange and sterile cinder range; crater-like peaks deeply disintegrated, with long absolutely bare slopes of black and red palagonitic fragments, piled up at the limital angle of rest like the slack from a mine, or the slag from a furnace. We seemed to be in a burnt-out world, as if we might be traversing the surface of the moon. The original palisaded structure of these mountains was destroyed, until they had become heaped-up cones of rubble with very dark cavities. They were the Kalfstindar in which Thoroddsen found intrusive basalts.

We descended from the "lava beds" by a steep path to a broad grassy flat meadow that skirted the very foot of the sinister Kalfstindar. The coloring, in brown, black and purple was extremely fine, and the sharp points of some hills falling away in long slopes of débris, with, here and there, remaining bulwarks of the parallel inter-

THE KALFSTINDER RANGES.

bedded igneous rocks, and with others broken down into broad mounds of flowing stream-like pebbles were wonderfully strange.

Iron oxide was significantly present everywhere, in the water and marshes, and, later, as we crossed peninsulas of outstretched combs from the mountain sides, it glistened as an iridescent film on the mirrors of the mountain streams. Heckla now came gloriously in sight over another arm of the immense plain, beginning in the Thingvallir vatn, and was superbly gleaming in its icy mantles, while removed from it to the south were the Tindfjallajökull and the Eyjaffjallajökull.

The beautiful Laga vatn spread its mirrory surface below us, imbedded in prairies of meadowland, and all radiant with unchecked sunshine, while along its edges and up its arms rose columns of snow-white steam from its hot springs. Here we stopped for rest at the farmhouse mentioned above, after skirting the mountains by an excellent narrow road winding through a shrubbery of dwarf birch, and huckleberry bushes.

The farm was characteristic. It consisted of five or six structures

A Little Oasis in a Lava Field.

in contact with each other, three with wooden fronts, and one with glass windows, the rest with doors entering dim vault-like chambers between immensely thick walls of stone, interleaved with turf. Behind the central wooden house, with the windows, was a high rick-like roof composed of turf and green with grass surmounted by a small square chimney, and this roof covered a crypt-like kitchen. This extraordinary troglodytal abode was entered over a stone pavement which, rising slightly, conducted the sightless visitor to the penetralia of gloom and cooking. Inside of this semi-subterranean passage, forming its walls, was a formidable structure of stone and turf. Turf and stone houses for sheep and cows and horses were scattered about. The walls of these buildings are five or six feet thick, and, once sealed in them, it seems likely that the heat of the imprisoned animals would maintain a very comfortable temperature, even in the dreadfully severe winters.

One peculiar feature of these farm colonies is the enclosure, like a wall, which marks them. In the farm I visited, this wall at one point was twelve feet thick. Within it the farm houses, a kitchen garden,

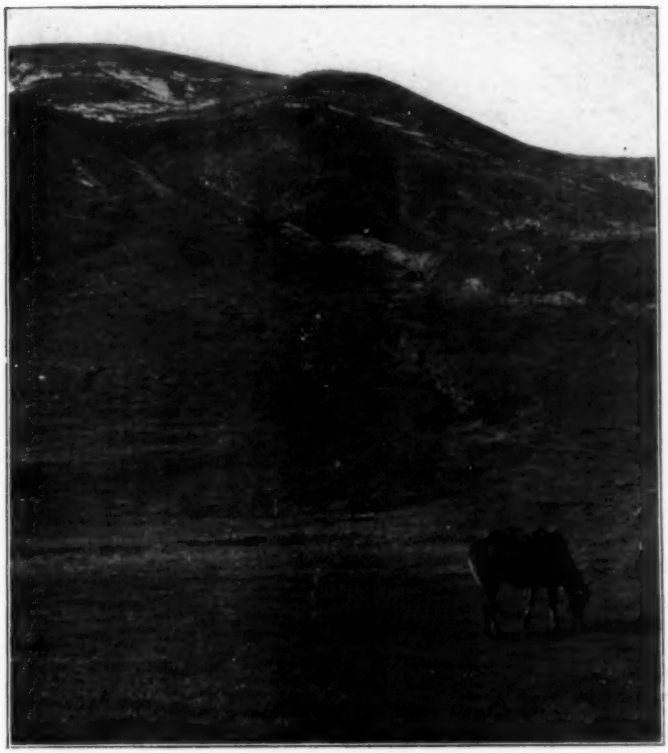
THE KALFSTINDER MOUNTAINS.

hay ricks and outlying folds are embraced, and curiously the floor of the enclosure around the houses is raised with turf, so that the whole resembles a low diminutive fortification. It seems probable that this is done to give stability to the "living unit," and enable it to withstand the mountain streams which surge around it in the spring freshets, when the mountain snows melt and to them is added the burden of deluging rains.

When we left this ideally placed homestead, in full view of the remote jökulls, of Heckla, of the Lagarvatn and its boiling caldrons, we followed the trend of the mountains, descending also to the plain below, crossing streams and zig-zagging over misleading trails. Gradually an intervening range on the horizon shut off Heckla, all but its steely cap, and over a soggy morass—the footing in such places is perilous from buried quicksands—we passed around a low mountain and found ourselves on the inclined plain of the Geyser basin, the steaming water holes emitting white plumes of condensed vapor over its verdureless tract. Long before we reached this expectant point where the object of our long journey revealed itself, we crossed one of

ICELANDIC FARM.

the most picturesque of the Iceland rivers—the Bruaau—or, at least, seen under the splendid blaze of the noonday sun, its snowy tresses and leaping crested waves appeared so. Formerly the dismayed tourist crossed it at a ford higher up than the present position of a very reassuring bridge, and the passage could not have been always easy. The water pours into a long medial crevice—splitting the basaltic floor of the stream—from either side, and, though the fall is slight, the concussion of the opposed tides is vehement enough to drive it up into turbulent waves that rush down the polished slope, below the crevice, in tumultuous disorder. At Geyser the visitor has arrived at a silicious ridge, undermined by tortuous passages, tubes and chimneys, which issue on the surface in a great number of holes, and, as Kuchler remarks, make a sieve of the ground. Some of these holes are gasping out a little sulphuretted steam, others are sputtering hopelessly with no results, others are quite lifeless, but present warm edges and yellow-stained throats; still other large circles are full to the brim of a pale green, beautifully clear, hot water, and you look down into chambers veiled and curtained with creamy geyserite. Many of



PALAGONITE, BETWEEN LAGANVATN AND GEYSER.

these latter are most fascinating. The larger, deeper pools are near the "hotel," and the Geyser itself is the center of a mound of sinter, about a stone's throw away. It forms a large circular pool, whose floor shelves off to a wide descending pipe, into which one eagerly strains one's eyes for a possible glimpse at the infernal machinery which works them all. It keeps its opaline eye staring wide open, sheds a few tears from time to time, which pour in little cascades down the slant outer sides, but never, by any chance rewards the tired spectator with an explosion. Still Geyser is an exciting sort of place, and what its bigger brother fails to do a much smaller fountain meritoriously endeavors to perform. In the morning and afternoon this industrious steam-pipe gets to work, and shoots up a column some fifteen to twenty feet high, and what is missed in magnitude is made up in the number and continuity of its emissions. It makes a very commendable restitution for the patience lost on its big somnolent companion. There is a very wide and profuse deposit of geyserite at this place which may extend a mile or so outward to the south from the hills north of the "hotel." Above the geyser plain on the hillside, about one hundred

ON THE WAY TO GEYSER.

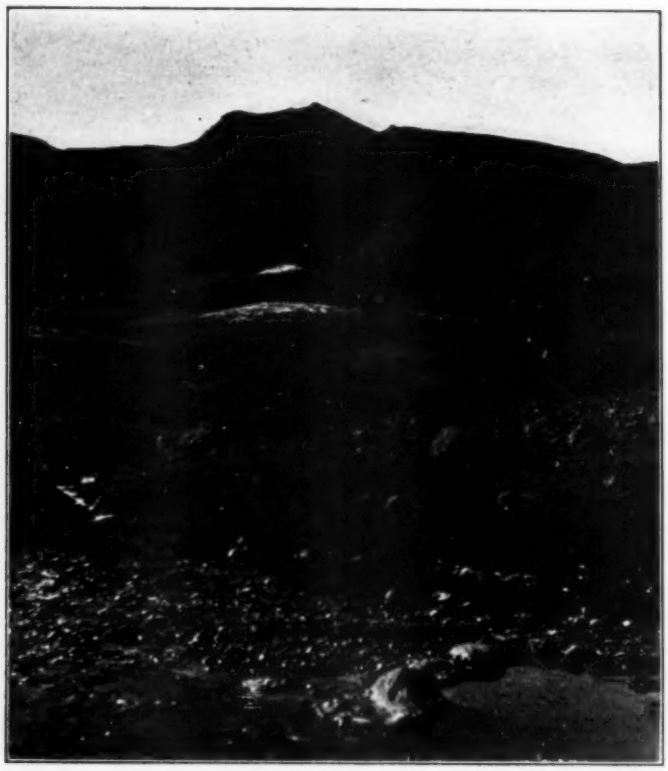
to one hundred and fifty feet, and below the trap of the Laugafjall are extinct geyser sites forming six to seven well-marked craters. The geyserite broken and disintegrated builds up these mounds, and they slope down to the upper *active* geyser tract by narrow fissures or defiles (water courses), between rounded low backs of red or white ochreous soil. The source of the heat apparently lies towards the north and probably below the trap-hills.

It seems also likely that a deposit has choked up the various channels of a few larger geysers, which have thus become dissected into a number of smaller ones which by tortuous passages now are probably connected with the original larger conduits.

Then on to Gullfoss, across a "bad" river, the Tungufljot, and ever a rolling country in which there are farmhouses, bogs and singular desert-like tracts of stony fragments and sand, which latter has been sculptured and heaped up by wind. On the way the glorious high back and silver surfaces of the Bläfellsjökull are seen shining against an icy blue sky, and behind an effective frame of serrated peaks—the Iarthettur—which blackly show up in minarets and saw-tooth outlines against its frigid sides. It made a supreme picture.

THE BRUAAU ON THE WAY TO GEYSER.

The climax was the Gullfoss. For half a century travelers who have reached this waterfall have given it their enthusiastic esteem, and as a "show card" for Iceland it's a winner. It is not so large, so immense; it does not possess mere physical dimensions, but it is a spectacle of astonishing beauty, and is so set in the loneliness of nature as to produce an astonishingly strong and thrilling impression. You come suddenly in view of it after the gallop over the sand plain, and its roar, the distant confused movement of the water and the shooting spires of spray fairly daunt you. Here the waters of the Hvitaau pour over one palisade of rock about forty feet high, and turning a right-angle tumble about one hundred feet into the whirling resounding gulf of a narrow, deep cañon that is cut southward between walls about three hundred feet high, which again farther south become almost one thousand feet in height. The upper fall is broken by intercepting partitions of rock. The falls are in process of recession, and the upper, by the more rapid removal of the possibly more easily disintegrated middle bed of rock, has slipped away from its lower companion. As the water boils and surges over the descending shelf between the upper and lower falls, it makes a very turbulent display.



THE LAUGAFIALL MOUNTAINS NEAR GEYSER.

Then it dips and drops into the hidden crevice somewhere below your feet, reappearing in the constricted throat below in awful commotion. As it drops, the dashed, splintered, pulverized masses of water send up sheets of vibrating particles from which the sun evokes a galaxy of rainbows.

The basalt rock is here seen in two series—an upper and lower—and these seem separated by slaty material. This last is, however, igneous in nature, though, peeked at from the overhanging cliff, it curiously resembles a conglomerate in spots, becoming, however, near the falls, columnar. There are curved heavy columns, and parallel and converging columns, in the rock at upper points of radiation in the lower flow. The top flow is divided from the lower by an interbedded formation, which also has a sedimentary appearance. The flows are well marked and the basaltic columns well developed.

We turned our ponies backward. It really seemed as if the great wonders of Iceland were only beginning. Heckla was abandoned for want of time, and we returned regretfully to Reykjavik.

The present-day Icelander has felt the stirring agencies which

CLAY AND GEYSERITE IN RAVINE, GEYSER.

everywhere in national life are advancing ideals, improving methods of living and awakening commercial ambition. This is more marked now since, after long years of almost fruitless agitation, the home government—I mean the governmental functions exercised in the island itself—is placed in the hands of Icelanders, and a practical sympathy with its needs has already established useful changes. It would seem dangerous to go too far in an effort to separate the island from Denmark, as a parental supervision implying support and protection is indispensable. The maintenance of banks, a more general utilization of a medium of exchange, increased facilities of obtaining manufactured articles, internal improvements, in the extension of roads, building of bridges, telegraph connections, have all sensibly contributed to awaken the Icelander, given him new satisfactions, stirred the desire for accumulation, and introduced to his attention new projects for the development of natural advantages, as, for example, the possible use of water power for electrical and manufacturing ends.

There is a strong mentality in the Icelander that is not inappositely united with imaginative power, and combined with distinctively reli-

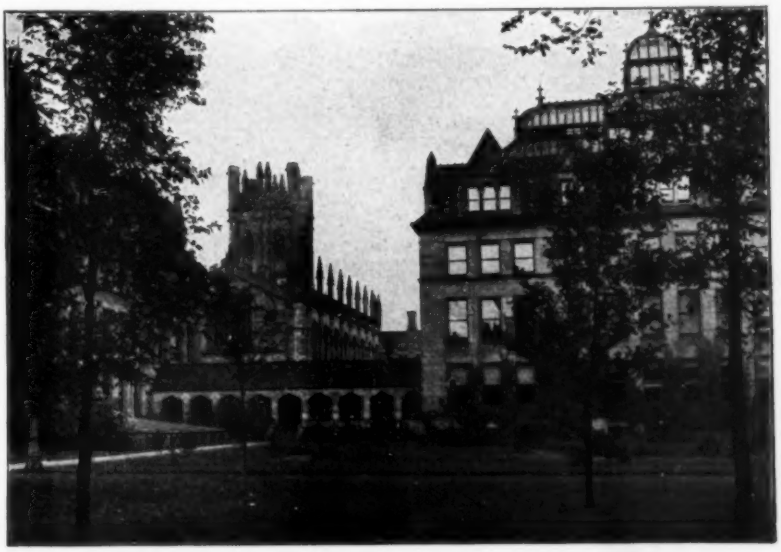
gious propensities; such a nature under the stimulus of education develops strong and helpful personalities and remarkable powers of acquisition. Scholarship is far from uncommon, and skill in composition is admired and displayed. A slight social segregation is perhaps becoming evident as competency, educational opportunities and self-indulgence separate an upper from the more peasant classes. Yet the traditional democratic instincts remain and will always assert themselves at any national crisis. At present, political agitation for some sort of hegemony should be discouraged, and every energy bent towards the processes of amelioration by which transit over and through the island will become facilitated, more of its interior occupied, flocks increased, manufactures laid down and comfort disseminated.

THE PROGRESS OF SCIENCE

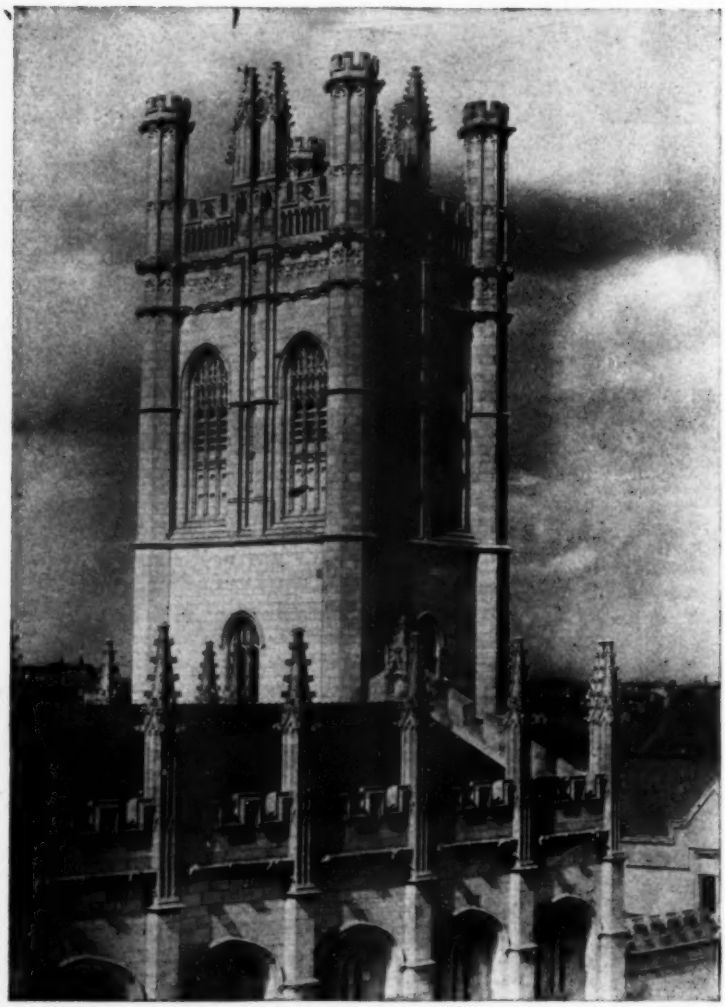
THE CONVOCATION WEEK MEETING AT CHICAGO

THE American Association for the Advancement of Science and the national societies affiliated with it meet this year at Chicago, beginning on Monday, December 30. Since the American Association changed the time of its meeting from summer to winter and entered into affiliation with the societies that had been in the habit of meeting during the Christmas holidays, there have been three large meetings of scientific men—the first at Washington five years ago, the second at Philadelphia three years ago and the third in New York City one year ago. The numbers of members of the association registered at these three meetings were, respectively, 975, 890 and 934. The registration, however, does not give nearly the total attendance, as many members of the association do not register, and all members of the affiliated societies are not members of the association. It is probable that the attendance of scientific men at each of these three meetings was over 1,500, and there is reason to hope that the approaching meeting at Chicago will be as large and as important from the scientific point of view as the meetings on the Atlantic seaboard.

The American Association is divided into eleven sections, covering the range of the natural and exact sciences. It includes sections for anthropology and psychology, for sociology and economic science, and for education, which last section holds its first meeting this year. The affiliated societies that meet in Chicago include, besides the American Society of Naturalists, the national societies devoted to physics, chemistry, geography, entomology, bacteriology, physiology, anatomy, botany, psychology and anthropology, and the western



NORTHEAST CORNER OF THE CAMPUS OF THE UNIVERSITY OF CHICAGO.



THE MITCHELL TOWER OVER THE GROUP OF BUILDINGS WHICH WILL BE THE HEADQUARTERS FOR THE MEETING.

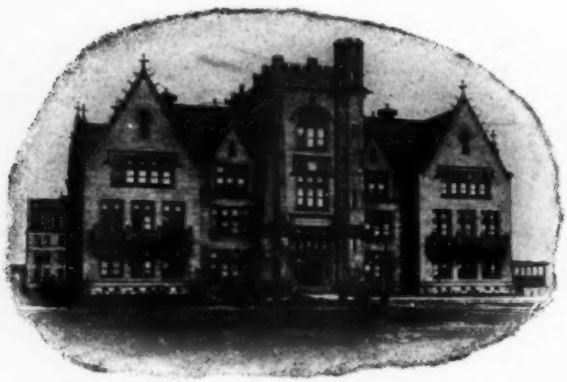
branches of the societies devoted to mathematics and to zoology.

The retiring president of the American Association is Dr. William H. Welch, of the Johns Hopkins University, who will make an address on the evening of the first day of the meeting. Dr. E. L. Nichols, professor of physics at Cornell University, is the president of the meeting and will reply to the addresses of welcome to be made by the president of the University of Chicago and others. Vice-presidential addresses are to be given in mathematics by Professor Kasner, of Columbia University; in chemistry, by Dr. Richardson, of New York City; in zoology, by Professor Conklin, of the University of Pennsylvania; in physics, by Professor Sabine, of Harvard University; in economics, by Mr. Conant, of New York City; in pathology, by Dr. Flexner, of the Rockefeller Institute for Medical Research; in economic and social sci-

ence, by Mr. Warner, of Cleveland, Ohio, and in education, by Dr. Brown, U. S. Commissioner of Education. Addresses of general interest will be given before many of the affiliated societies, and there will be a large number of discussions, such as the one before the American Society of Naturalists on cooperation in biological research, in addition to a very large number of special papers to be read before the sections and societies.

The migratory meetings of the American Association enable it to bring to different centers a large proportion of the active scientific workers of the country, who should stimulate the intellectual activity of the community, while at the same time the members of the association have each year the privilege of a visit to an educational center, from which they can perhaps profit as much as from the programs of the meetings. The association has not met in Chicago for forty years. During this period science and higher education in this country have entered upon a new era, and during the latter part of it Chicago has assumed its proper place of leadership. Northwestern University opened its doors in 1855, and with its well-organized schools and four thousand students has become one of the leading universities of the country. The Field Museum of Natural History, organized at the close of the exposition of 1893 and recently endowed by Mr. Marshall Field with a bequest of $8,000,000, is one of the great museums of the country and of the world. Of special interest to the visiting members will be the University of Chicago, where most of the meetings will be held. Thanks to the vast gifts of Mr. John D. Rockefeller and the liberal cooperation of the citizens of Chicago, seconded by the organizing ability of the late President Harper,

THE WALKER MUSEUM OF GEOLOGY.



THE RYERSON PHYSICAL LABORATORY.

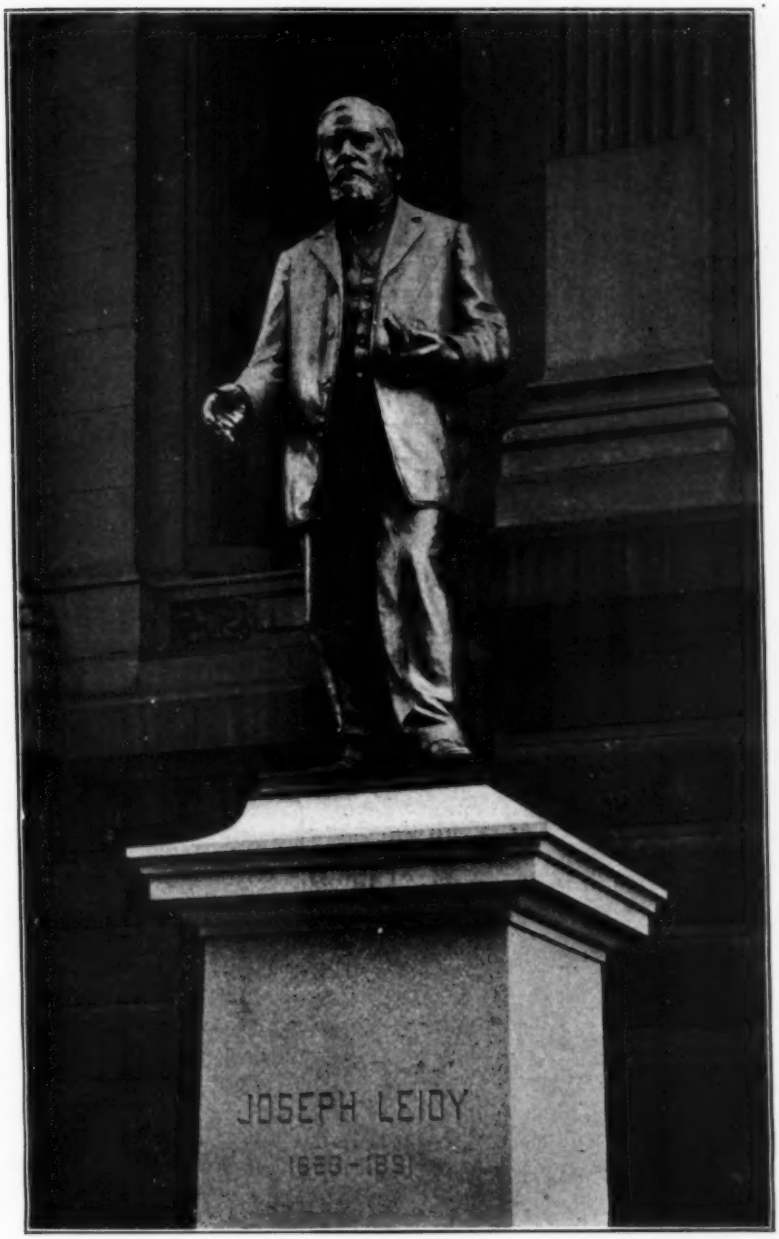
the University of Chicago has enjoyed during the fifteen years since its foundation a development unparalleled in the history of education. Its grounds and buildings, its museums and laboratories, its educational methods and above all the great group of scholars and investigators who make the university will attract to the approaching meeting men of science from the whole country.

A STATUE OF JOSEPH LEIDY

OUR cities are more likely to erect monuments in honor of soldiers and statesmen than to commemorate in this way their intellectual leaders. Philadelphia should therefore be congratulated on having placed by its city hall a statue of its great naturalist, Joseph Leidy. Thanks most of all to him, but also to a group of fellow students, Philadelphia maintained for a time during the second half of the last century a certain preeminence in natural history. We may hope that the dedication of this statue of Professor Leidy on October 30 indicates that the city appreciates the golden age in its history, and will seek to regain its leading position as a center for research in biological science.

Joseph Leidy was born in Philadelphia in 1823; he spent his life in that city, and died there in 1891. He graduated from the medical school of the University of Pennsylvania in 1844, and maintaining his connection with the university as assistant and demonstrator was elected professor of anatomy in 1853. His connection with the Academy of Natural Sciences was equally long and intimate, and he was also professor at Swarthmore College. His scientific work was closely connected with Philadelphia. Most of his six hundred papers were published in the proceedings of the academy and of the Philosophical Society. His paleontological papers were based mainly on the collections of the academy, and his work on recent invertebrates on material collected in and about the city.

Leidy published over two hundred papers on the extinct vertebrates of North America, leading in the work in which he was subsequently joined by Cope and Marsh of describing the remarkable fossils of the western plains. As early as 1847 he showed that this continent was the ancestral home of the horse, whose phylogeny is one of the most interesting chapters in the history of evolution, and this paper was followed by others describing the lions, camels, rhinoceros and other mammals and reptiles, which have now no immediate representatives on the continent. Perhaps equally important was Leidy's work on parasites, on



STATUE OF JOSEPH LEIDY.

fresh-water rhizopods and on other lower forms. In 1847 he discovered the trichina in the hog, and his "Flora and Fauna within Living Animals" is a classic on this subject. His work covered an immense range. He was well informed in botany and in mineralogy, and was master of the whole field of zoology, anatomy and paleontology, both on the side of the laboratory and of nature. The complications of modern science make it unlikely that there will be another man of his type. Men must now be more specialized and smaller, and this seems to hold to a certain extent for character as well as for scientific work. Leidy was not only a great naturalist, but also a great man—simple, kind, generous and just.

SCIENTIFIC ITEMS

WE regret to record the death of Professor Asaph Hall, the eminent American astronomer.

NOBEL prizes have been awarded as follows: In physics to Professor A. A. Michelson, of the University of Chicago; in chemistry to Professor Eduard Buchner, of the Berlin Agricultural School; in medicine to M. Laveran, of Paris; in literature to Mr. Rudyard Kipling, and for the promotion of peace to M. Renault and M. Moneta.—The Copley medal of the Royal Society has been awarded to Professor A. A. Michelson, of the University of Chicago, and the Davy medal to Professor Edward Morley, emeritus professor of chemistry of Western Reserve University.—Professor Simon Newcomb has been elected a foreign member of the Göttingen Academy of Sciences, Mr. Alexander Agassiz of the Vienna Academy of Sciences, and Dr. G. W. Hill and Professor H. F. Osborn, foreign members of the Edinburgh Royal Society.

AN oil portrait of Professor James Mills Peirce Perkins, professor of mathematics at Harvard University until his death in 1905, has been presented to the university by his sister. —A portrait of Professor Arthur Schuster has been presented to Manchester University. It will be remembered that Professor Schuster recently retired from the active duties of the chair of physics.

MR. ANDREW CARNEGIE has added two million dollars to the endowment of the Carnegie Institution of Washington. Mr. A. J. Montague, of Virginia, and Mr. W. B. Parsons, of New York, have been elected trustees of the institution.